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Parachute Bombers For Offense PAGE 82

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(Continued on next page)

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by J. E. Thompson, B.S. in E.E., A.M., Dept. of Mathematics, Pratt Institute

(Continued from facing cover)

solve problems which are involved in all military and industrial work, relating to machines, engines, projectiles, ships, planes, etc. Logarithms and slide rule, and many other practical applications.

GEOMETRY: States clearly all needed facts about plane figures, circles, polygons, etc. Covers all the topics essential in drafting and engineering. It deals at length with angles, triangles, circles, and the many other geometric figures that are basic to engineering design. Sheet metal work, so important in airplane construction, is a direct application of these principles. So also is the laying out of ship hulls, which is the major activity in ship construction. The properties of circles and spheres explained in this volume also apply directly in navigation.

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POP. SCIENCE 5-42

POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 140 NO. 5

Mechanics & Handicraft

THE NEWS PICTURE MAGAZINE OF SCIENCE AND INDUSTRY

CONTENTS *for* MAY, 1942

News

Automobiles

Home and Workshop

Departments

(Contents continued on page 4)

ALDEN P. ARMAGNAC has been writing articles on scientific subjects for more than 15 years. Trained for chemical engineering at Columbia University, he combines an encyclopedic knowledge of technical matters with the rare ability to make them interesting and understandable to the layman. Hobbies: collecting butterflies, playing the banjo and guitar.

Published monthly at 353 Fourth Avenue, New York, N. Y., by Popular Science Publishing Co., Inc. Godfrey Hammond, President and Treasurer; R. C. Wilson, Raymond J. Brown, Vice Presidents; F. W. Briggs, Secretary. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U.S.A.

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Contents [CONTINUED]

Automobiles

Aviation

Facts and Ideas

Inventions

Craftwork

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...QUICKLY

It's reassuring these days to see those sturdy Bell System trucks along the highway.

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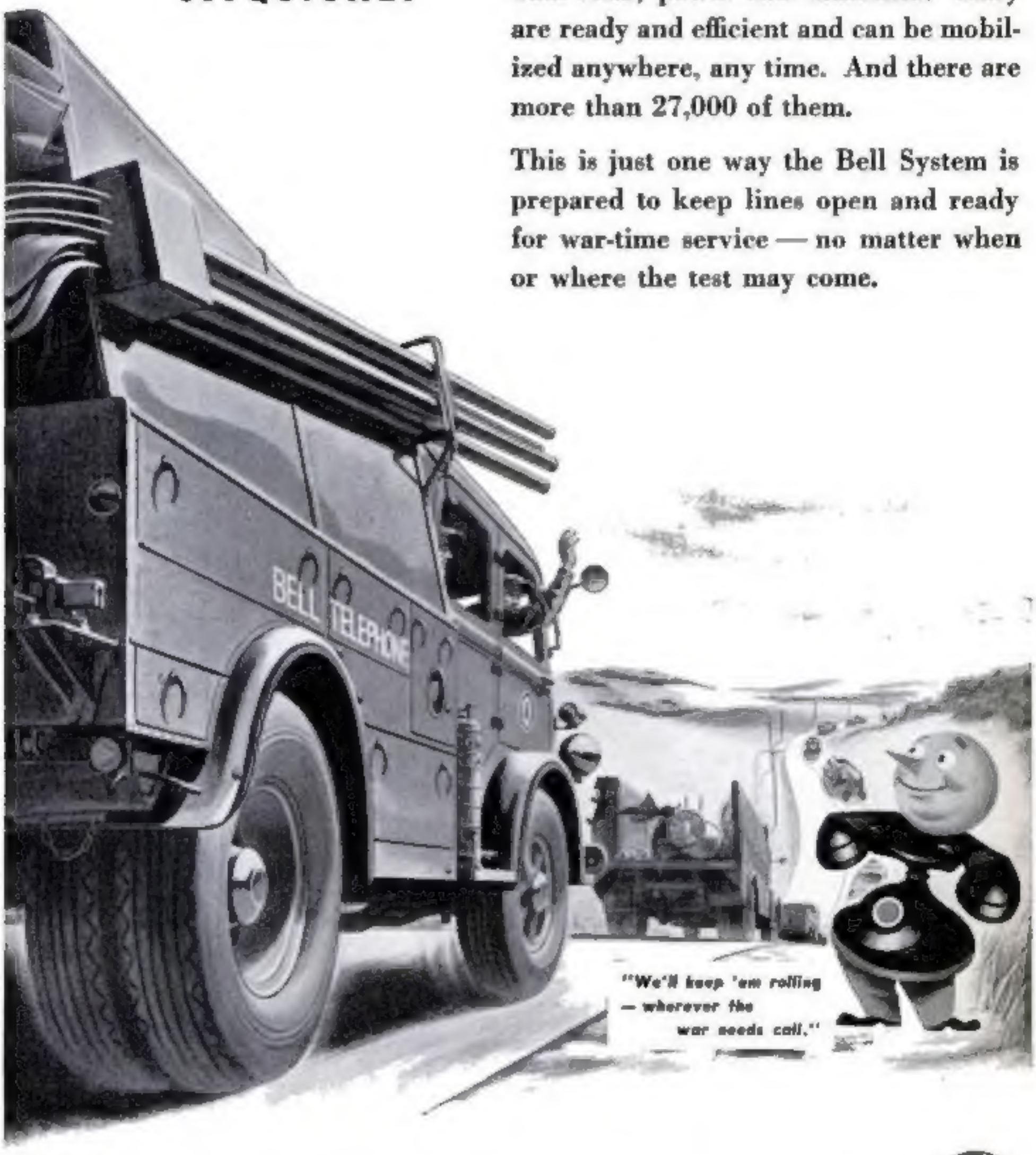

BELL TELEPHONE SYSTEM *Service to the Nation in Peace and War*

Contents [CONTINUED]

Home Building

Miscellaneous

New Shop Ideas

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Contents [CONTINUED]

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SULFANILAMIDE is a name to conjure with in the realm of medicine. With its derivatives, it is saving human life and relieving human suffering on a scale that may counterbalance the death and misery brought by the war. What are these miracle drugs, and what do they do? Carl Dreher gives the answers, in language that a layman can understand.

DEMOLITION—blasting roads, bridges, and enemy defenses—is one of the strange weapons of modern war. Our own Army has its specialists in this line, men who handle dynamite and TNT as confidently as the doughboy shoulders his Garand rifle. You'll want to read about the methods employed by these masters of destruction.

A DRILL PRESS for the woodworking shop? Yes, indeed! Although usually associated chiefly with metal work, this power tool can be a great timesaver in boring, routing, shaping, mortising, sanding, carving, dovetail cutting, and dowel making. Edwin M. Love tells you how to set it up and how to use it in woodworking.

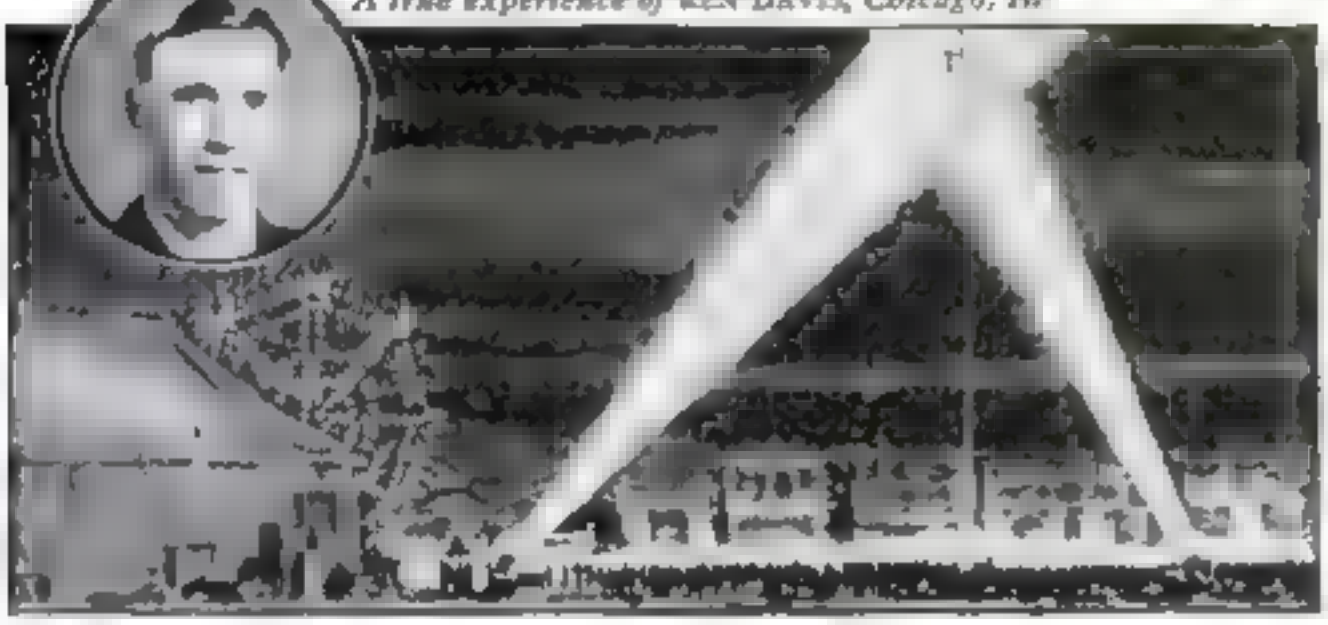
HOW OFTEN have you watched in amazement as a rodeo star put a lariat through its paces? Secrets of rope tricks are shown in a "How it is done" article illustrated with photographs of one of the country's best rope artists in action. Give a reader enough rope and he'll make himself a lasso.

"TOPS" is a new plywood boat designed for the man who wants a portable, all-around utility boat for fishing and hunting trips or family use. Carried on top of your car, it needs no trailer—an important consideration in these days when an extra pair of tires isn't easy to get. Complete plans and instructions are given for this timely project.

YOUR STORAGE BATTERY is one of the vital organs of your car. Now, more than ever, it is important for you to know how it is made, what it does, and how to treat it. Schuyler Van Duyne tells you just those things in an instructive article. A careful reading will help you to get longer, more dependable, and more economical service from this often neglected automotive necessity.

"THE HORRIFIED CROWD GASPED AT MY PLIGHT!"

A true experience of KEN DAVIS, *Chicago, Ill.*



"SEVENTY FEET ABOVE the crowd at a carnival, I was performing my high aerial act," writes Mr. Davis. "I was a bit nervous, for this was our opening night . . . when anything can happen. I work without arm guards, wires, nets, or safety devices of any kind. There can't be any mistake in such an act.

"THE CROWD WAS TENSE as the climax of my act drew near . . . when I had to turn loose both rings, perform a half flip in mid-air and catch the rings again. It was sudden death if I failed. As the snare drums rolled, I swung high and loosened my grip. Then—*darkness* as all the lights went out!

"FOR AN AWFUL INSTANT I thought I was a 'goner.' Suddenly—in the nick of time—the bright beams of two 'Eveready' flashlights in my wife's steady hands flooded the rings with light. I finished my act. Thanks to my wife's coolness and foresight, and those dependable 'Eveready' *fresh* DATED batteries, a possible tragedy was averted. *(Signed)* Ken Davis"

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From the News Editor's Desk

BY WEIGHING HEAVY MEN under the surface of water, the Navy's medical corps can now tell whether a man is a "fatty" or just a plain heavyweight. The object of this novel test is to determine body density or specific gravity. As fat has a comparatively low specific gravity, Navy surgeons believe that measuring the specific gravity of the body mass in this way should give a fair estimate of the fat content of the body. The specific gravity of a healthy man between the ages of 20 and 40 falls between 1.021 and 1.097 according to naval surgeons. A lower measurement indicates obesity, while a higher indicates leanness.

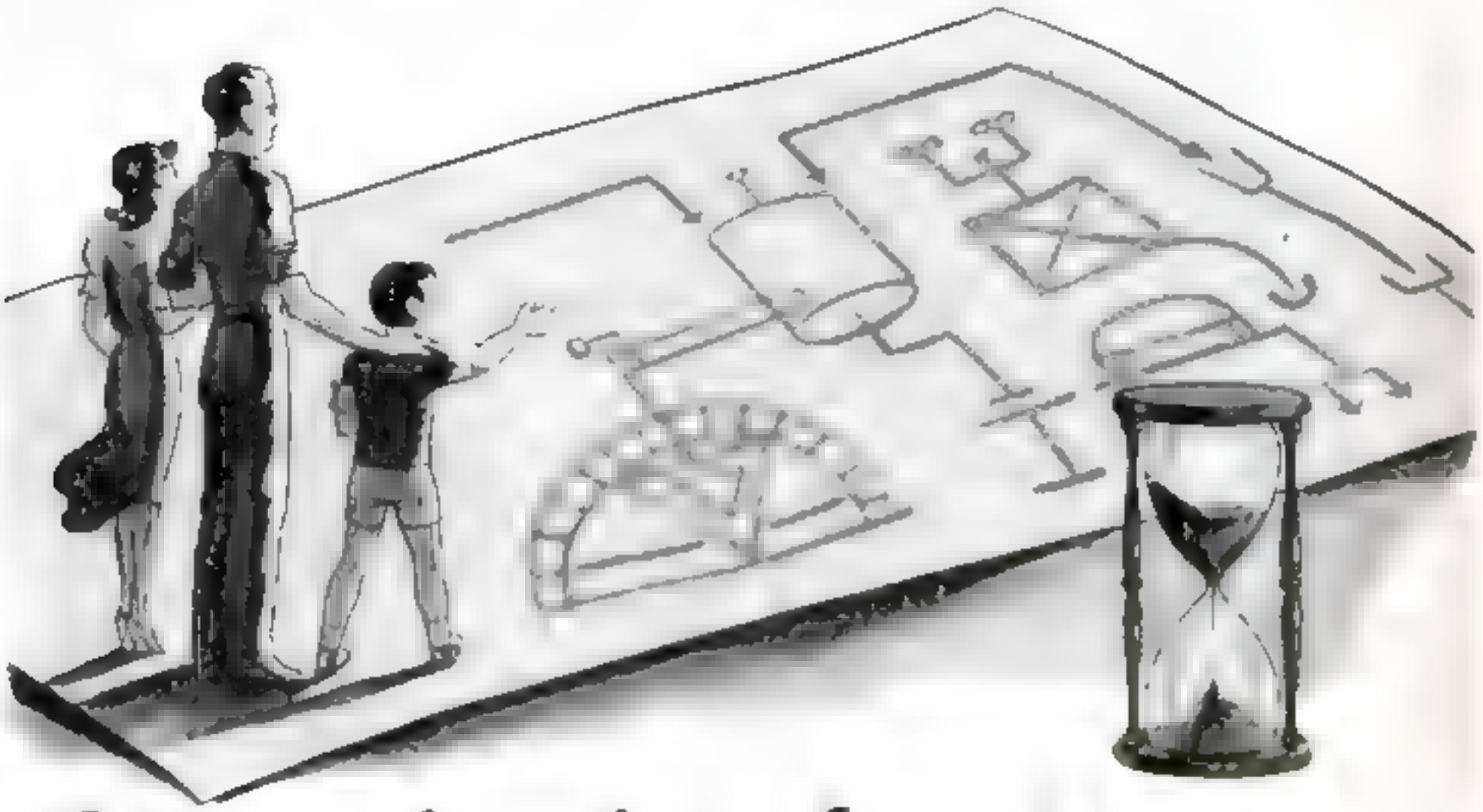
RADIO AMATEURS are being asked to sell their transmitters and receivers for use by the armed forces of the United Nations. According to the American Radio Relay League, manufacturers are unable to fill orders for standard equipment under the present conditions. The greatest need is for standard transmitters, although it has been estimated that only five percent of the amateur transmitters are factory-made. Homemade or "composite" equipment is not required at present.

MAGNESIUM CAN NOW BE PRODUCED from dolomite, a very common form of limestone. The essential steps of this new process include the introduction of carbon dioxide under pressure at one stage and heating the stone to a high temperature under vacuum, in the presence of calcium carbide, in the concluding stage. The result of this thermal reduction process is said to bring out part of the magnesium as pure metal. The residue, which consists of magnesium and calcium oxides, is dumped back with the raw dolomite and the process repeated.

CHOKING FUMES that pour from many factory chimneys can now be turned into a new and useful chemical solvent. These fumes are sulphur dioxide which, when cooled to a temperature of 14 degrees Fahrenheit, liquefies into a waterlike substance with great chemical possibilities. Certain compounds of sulphur and cyanogen can be produced in no other way than by the use of this new solvent. It may also be useful in the preparation of insecticides and other poisons.

TAGUA NUTS FROM ECUADOR have been fashioned into buttons for soldiers' garments owing to the shortage of the usual button materials in the United States. Known as "vegetable ivory," taguanut buttons are said to withstand cracking under pressure and intense heat and remain color-fast after numerous washings and strong sunlight. The U. S. Army has recently purchased 2,592,000 of these buttons to be used for all soldiers' garments except those requiring metal buttons.

LIFE IS WHAT YOU MAKE IT....



Here Is An Intelligent Plan For Successful Living

EVERYONE has a final aim — something he wants to accomplish. Failure to achieve it is usually due to the method used—*or lack of one.*

How much nearer the realization of your ideals *are you today* than five years ago? Are you sure you have put forth your best efforts? Working long hours and forgoing pleasures are not sufficient to assure success. What are you psychologically and emotionally best fitted for? Remember, what you like to do is no test of your capabilities.

There are two ways to live. One is to exist, accepting events as they arise. The other is to *plan* a future—and put yourself, all of yourself into it. *No intelligent plan of living* can exclude the *human factors,* the qualities and powers of self—*imagination, intuition, will power, concentration,* and *memorizing.* If you seek to master life by attention only to the world *outside* of yourself, you are doomed to further disappointments.

You are the beginning of *every* enterprise that concerns you. But what do you know of yourself? No mechanic, draftsman, or businessman starts a campaign or a venture without a thorough understanding of his tools and instruments. *You* are your greatest instrument—don't dissipate your capabilities. Learn to apply them intelligently and enjoy gratifying results.

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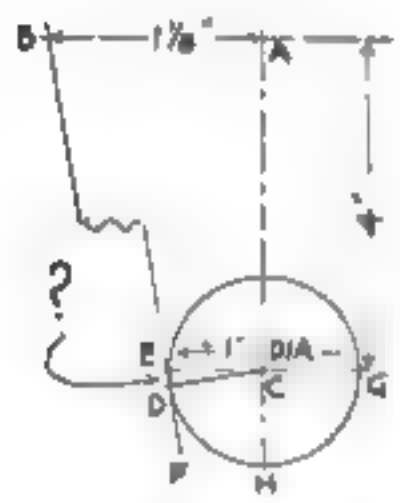
Readers Say:

If Diophantus Was Too Easy, Take a Try at This One



IN MY work as a draftsman I occasionally run across a fair mathematical problem, and I am sending you this one. It can be solved by a combination of geometry and trigonometry, and also by calculus. In the drawing, the circle is one inch in diameter and has the line BF tangent to it at D. CA equals four inches, AB 1⅛ inches. HAB is a right angle. What is the distance DE?—C. M. G., Calgary, Alberta, Canada.

Perpetual-Motion Idea Has Just One Drawback

I NEVER had the materials to try this, but couldn't perpetual motion be obtained by hitching a generator to an induction coil and this to a motor which would, in turn, turn the generator? Of course the parts will wear out some day, but until then some free power may be obtained. If this is a real invention, just let me know and I will patent it before you publish it (Ha-ha).—B. B., Washington, D. C.

Reader Designs and Builds His Own Typewriter Table

HAVING noticed in P.S.M. a description and illustration of a typewriter desk, I thought I would send you a picture of one I made in my garage workshop. It is designed to suit my personal needs in the house. I find it very compact and handy, and all who see it compliment me on its beauty and usefulness. While it is rather modernistic in design, it fits in nicely anywhere. It is oak frame, paneled with plywood and veneered with black walnut. Varnish is the only finish, being well rubbed to a high polish. A shelf-type drawer holds the portable typewriter. The matching chair is of solid black walnut, with needlepoint seat cover. I am a city fireman and get a big kick out of my workshop. I have made other furniture for our home and have gotten many useful ideas from P.S.M.—H. P. W., Downey, Calif.

English Technical Student Earns His Own Workshop

AS A student in a technical high school, I am specially interested in your magazine. Since coming from England in 1940 I have had a workshop of my own, with a wood-turning lathe. I paid for it with money I earned at handy jobs. I hope some day to get more machine tools for my shop, but now they are restricted. Whenever P.S.M. arrives, I race through it to the workshop section. I also follow Gus's adventures with great enthusiasm.—S. J. S., Cambridge, Mass.

If Only He Liked Photography, the Score Would Be Perfect

I ALWAYS read practically every article in POPULAR SCIENCE MONTHLY, except those dealing with photography. I just don't happen to be interested in that subject, though I suppose a great many of your readers are. My habit in reading P.S.M. is to start at the front and read everything as I come to it. The only other magazine I read in this manner is *Readers Digest*. If I were in such a situation that I could have only one publication to read the rest of my life, it would simmer down to a choice between P.S.M. and *Readers Digest*, with *Fortune* possibly included.—L. S. V., Oklahoma City, Okla.

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A cost clerk, J. S. H. became, after completing 30 training assignments, cost accountant. Within nine months, only half through the course, he became chief cost accountant with a salary nearly four times what it was when he enrolled. C. K. was an immigrant day laborer. Within a few months he secured a bookkeeping job. Within a year, he secured three raises. In two years, he was in charge of his company's accounting department, although not yet through the training. W. J. F. moved up from store clerk to assistant bookkeeper after the first ten lessons. Now he is office manager. S. W. N. knew nothing about bookkeeping. With 19 months of training he passed the C. P. A. examination on first attempt and opened his own public accounting office. Although a university graduate, P. M. was a grocery clerk at small wages. Today he is Secretary and Credit Manager with an income 300 per cent higher. Already in cost work, G. N. P. within nine months was earning 40% more; within two years, 100% more. The third year his income went up still more. Now he is manager.

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Readers Say:

We Made a Bad Break on That Metal-Working Brake

IN YOUR March issue, on page 107, you have a picture of men working in the mobile repair unit of the Air Force. The caption states that the men are shearing a piece of metal. Really, these men are operating a "brake" which is used for bending or breaking metal sheets.—W. J. W., Hyattsville, Md

Reader Goes Off Half-Cocked About Coast-Defense Guns

As I was reading a back number of P.S.M. for November 1941, I noticed that on page 98 you show a 16-inch howitzer and a 14-inch disappearing gun, both with approximate range of 14 miles, but on the drawing the two ranges are represented by lines of different lengths. You may have some reason for this, but in my country 14 miles is 14 miles. Could you please explain in Readers Say?—E. B., Waterbury, Conn.

If they have rulers in E. B.'s country, he might try measuring the lines representing the ranges of these two guns. He will find that from the gun muzzle to the end of the line is 2¾ inches in either case.—Ed

Radios to Rent in Hospitals Would Entertain Shut-Ins

MY RELATIVES bring your magazine to help me pass the time while I am in the hospital recovering from an operation. Seeing the descriptions of different kinds of radios gave me an idea which you might pass on to radio dealers. Why not have small radios to rent by the week to sick people? If it is nice to listen to the radio when you are well, how much nicer it is when you are sick and lonesome!—Miss Z. R., Hays City, Kans.

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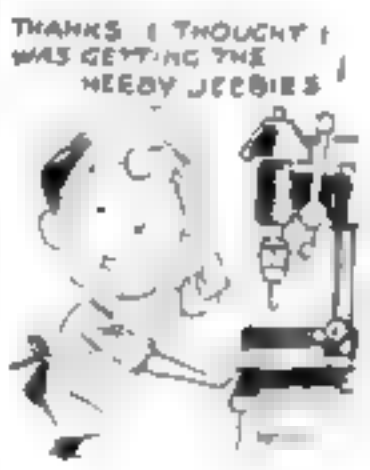
Readers Say:

That Stroboscopic Effect Works on Drill Presses, Too

RECENTLY I read in your magazine of the stroboscopic effect of the household power supply used in conjunction with an automobile fan. I had in mind to try it out, and the last time I had the car in the garage making minor adjustments I tried this experiment and it worked. I'm a drill-press operator and what I have to say concerns this same experiment in relation to a drill. We have presses in our shop controlled by rheostat and can regulate the speed of the spindle from 860 to 8,600 r.p.m. Some of the machines are already equipped with built-in lights, while others have desk lamps. Well, the ones with the desk lamps are the ones on which the stroboscopic effect can best be seen. The thing to do is to turn the machine on about 3,400 or 4,300 r.p.m., and then turn off the switch. If you watch the drill carefully as the spindle begins to slow down, the twist will become readily visible and will slowly go down to the end of the drill and rise again to the chuck, and finally it will go down to the end. With a very free-working spindle, this rising and falling of the twist can be seen for a number of times.—E. S., Chicago, Ill.



Fill 'Em Up with Cigars and Send 'Em to Us

SINCE uses have been dug up for C. M.'s shirt cardboards and E. J.'s old alarm clocks, can anyone tell me what to do with 25 empty cigar boxes?—B. G., Canton, Ohio

For shame, B. G.! An empty cigar box is one of the most universally useful things in the world. If you asked us what you can't do with one—well, we couldn't say.—Ed.

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He'd Like to Know More About Automatic Addressing Machines

Some time ago I wrote to an insurance company, asking that premium-due notices on two separate policies be mailed in one letter instead of separately as heretofore. Their reply was that they could not do as I asked because all notices are mailed automatically a number of days before the premiums are due. Since POPULAR SCIENCE is my favorite magazine, I would like to see an illustrated article in its pages about these automatic mailing machines. I believe other readers also would like to know more about machines used in large business offices.—G. L. W., Pondosa, Ore.

Hone for Safety-Razor Blades Makes 'Em Go Farther

I don't know that I can answer the questions raised by W. C. C., of Delaware, Ohio, regarding the edge of a razor blade, but I can tell him how to keep a keen edge on a blade. There is available a concave hone for double-edge safety-razor blades. Thousands of them have been sold, and although many of the buyers may not have gotten the expected results this was probably due to their lack of skill. In sharpening a blade on one of these hones, it is placed in the concave groove and rotated gently with a finger. If the edges of the blade are not kept parallel to the groove, the blade will be ground on the corners instead of along the entire edge. When properly used, such a hone gives very satisfactory results and will maintain a sharp edge on a blade for weeks.—R. H. S., West Hartford, Conn.

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(Continued on page 24)

Plans for the Workshop

(Continued from page 22)

Sectional Rowboat, 9' 8" long, can be used with small outboard. 340-341-R ..... $ .75
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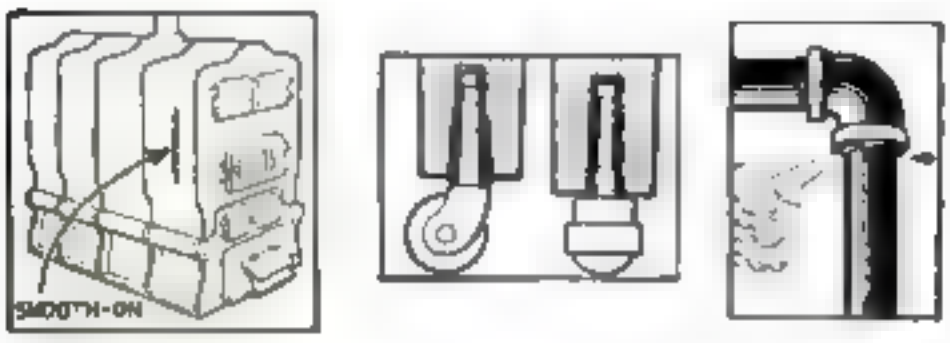

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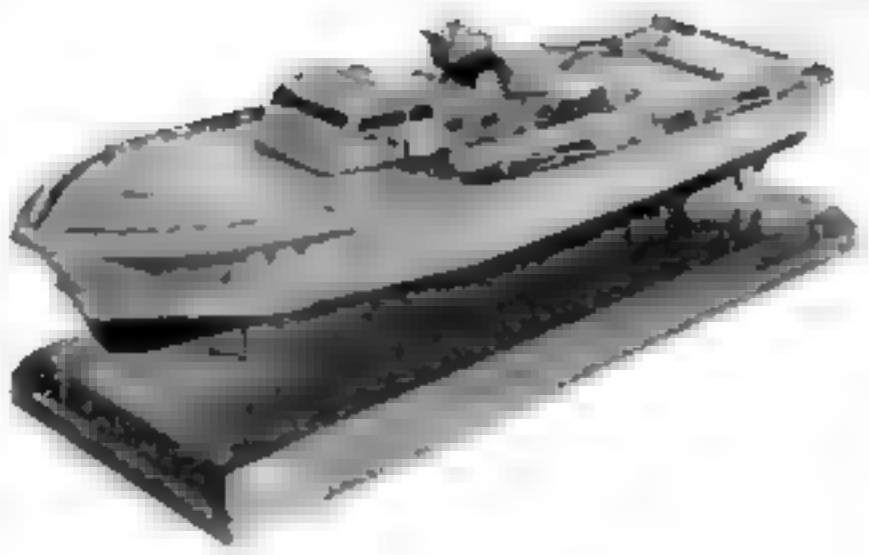

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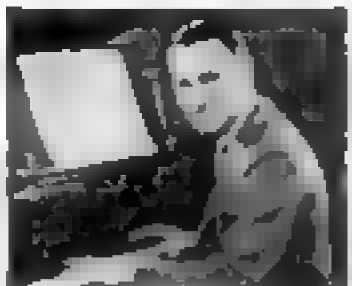

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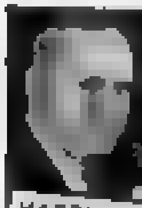

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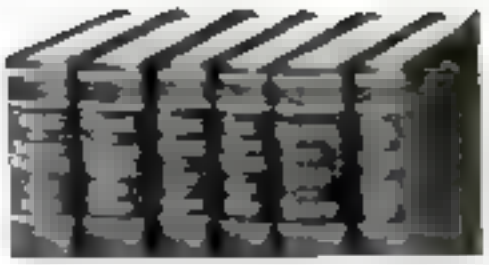

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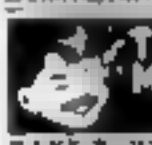

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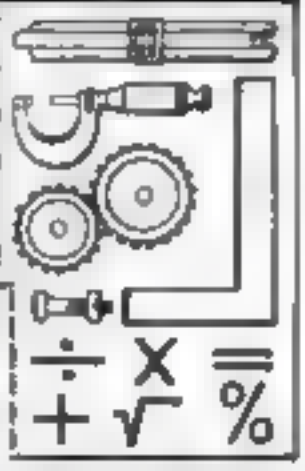

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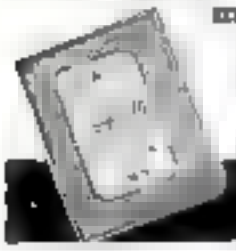

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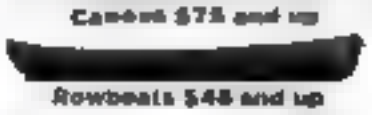

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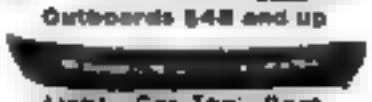

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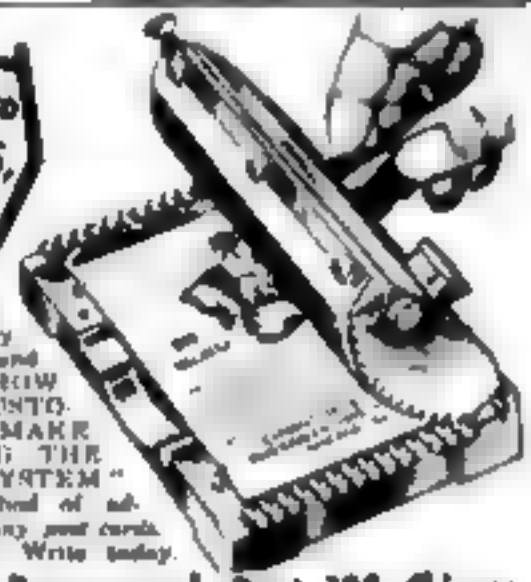

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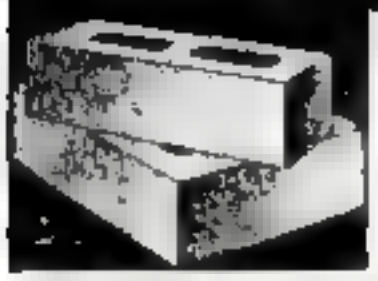

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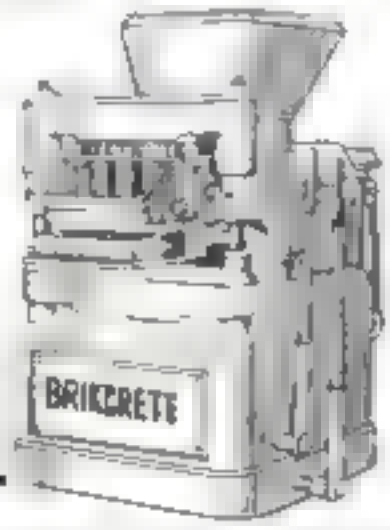

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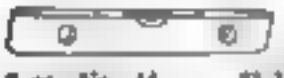

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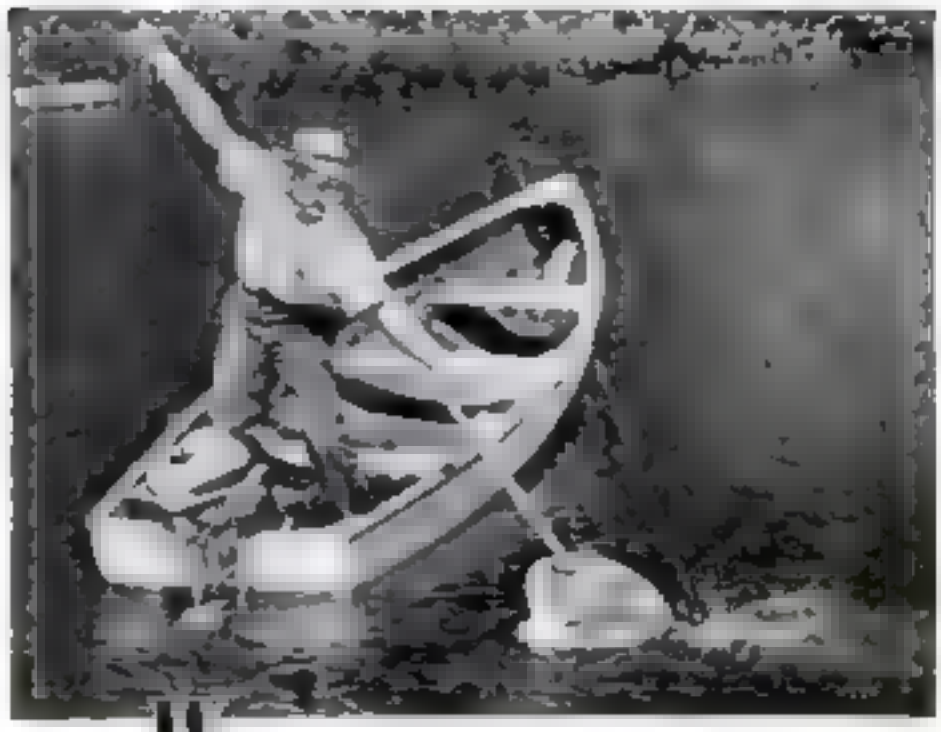

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POPULAR SCIENCE Monthly

For this 70th Anniversary Issue, we asked "Boss" Kettering, as a leader in American research, to examine the future opportunities in the fields of industry and science. And here is his answer:

NO SHORTAGE OF PROBLEMS

By CHARLES F. KETTERING*

WHENEVER anyone asks what effect the war is going to have on engineering progress, I think we should remind ourselves that it is going to have exactly the effect we permit it to have. The war-born shortages of critical materials and skilled labor are going to bring us face to face with new problems never dealt with before. If we permit these problems to discourage us, engineering progress will come slowly to a standstill. But if we attack them with the same vigor and determination that have characterized American engineers in the past, we are going to enter into an age of opportunity and development such as we never experienced before.

We must understand that war can be either a green light or a red light to progress. And which it becomes depends entirely on us. We set the signals. Some work must be stopped to get the materials for war, but we don't have to mentally stop our work and dig in for the duration. We must take advantage of the great impetus which these problems can give and move triumphantly toward greater mastery of the universe in which we live.

The answer we make to this question is extremely important to the young men who are going to be running the industries of tomorrow. It is one of the most important questions we face today. We are building the future now; the opportunities and hopes of millions of young people are in our hands. What are we going to do about them?

A great many people today are asking, "Has science ruined the world or is it saving it?"

You can get on both sides of a question like that. Not long ago I happened to attend a meeting at which the toastmaster was an economist. He said, "The scientists are dragging the world to chaos. No stable civilization can exist as long as inventors continue."

In the course of the meeting I had an opportunity to reply to him. I told him that no one was forcing him to use any of the things that science had produced. All he had to do was to decide when he should have liked for progress to

*Vice President of General Motors in Charge of Research, inventor of the automobile self-starter. Chairman of the National Inventors Council, which sifts ideas offered to the Government for use in our war effort

stop. Then it would be easy for him to go back to the optimum and live happily.

Only a short while later I was thrown in contact with the same man when he was extremely ill. He had a streptococcus infection, and his doctor had told him that he did not have much chance to recover. The sulphone compounds had just been discovered at this time, and I happened to know several doctors who had already acquired considerable experience in using them in the treatment of strep infections.

10TH ANNIVERSARY Feature

I told him, "You can save yourself, but you will need the work of some scientists to help you do it."

"Please do anything you can," he said, "I don't care how much it costs."

Within a week he was cured. Now he has had a complete turn of heart, and I have not heard him say once since that time that he would like to stop scientific progress. It can't be stopped because we know so little.

If we are going to be really hardheaded about this business, we had better recognize the fact that progress isn't something that can be started or stopped by turning a spigot on or off. There is no standing still in nature. Either we move forward or we slip backward. Americans have always prided themselves on being a progressive people. Our inventors and engineers are the finest in the world. We need their services now. This is not the time to attempt to stop progress. If we are going to win the war, and we most certainly *are* going to win it, we must have an "all-out" scientific contribution. Now, more than ever before, we must keep our laboratories running and our inventive minds busy.

"Progress isn't something that can be started or stopped by turning a spigot on or off."

We have two great problems. First, we must win the war. Second, we must have something to do after the war is won. Most of us retain a very clear picture of what happened after the last war. We entered into a period of depression and prosperity and then depression once more, and we came out having excesses of men, money, and materials such as no country in the world had ever had before. Our problem then was to find some profitable employment for our excesses. Today our problem is one of shortages, but eventually we are going to have to face that problem of excesses again.

I am perfectly willing as a representative of our so-called researchers and inventors to take full responsibility for that condition. The only way I can see that we could have excesses of men, money, and materials was not to have enough projects, and it is the duty of the researcher and inventor to develop new things so that we can have enough projects to provide employment and a decent standard of living for every-

This is a mechanized war, and the new things that are going to come out of it will be simply amazing. In the automobile industry alone, we are already changing many of our old ideas. When the war is over, we are going to have new fuels and materials such as we hardly dared even to dream about before. We are going to learn how to build vehicles for types of service that would wreck any ordinary car in less than an hour.

The other day I was talking to a group of men who asked, "Why is it that the Army can't use the same kind of trucks we use in industry?"

The simplest answer to that is the fact that industry's trucks are made to run on highways, while the Army has to run theirs on everything but the highways. They can't get the enemy to come down to the road, so they must be able to chase them through fields and over gullies. That is why we have four-wheel drives and six-wheel drives. It's not a thing that we should complain about. For the boys who are doing the fighting, it's a matter of giving them the best fighting equipment we know how to build. For those of us who are doing our job in industry, it's an opportunity to obtain a lot of valuable experience in doing something which is going to play an important part in our progress in the future.

If we are fighting a mechanized war, we might as well understand what it means. I would like to take the cellophane wrapping off of that word "mechanized" and see exactly where we fit into it. We have been in the automotive business so long that I sometimes think we forget what we are

doing. Automotive simply means self-moving. The automobile is a power vehicle, and the automotive industry is a power industry. When we talk about mechanized war, we are talking about power war.

The installed power of all the central stations in the United States now amounts to about 40,000,000 horsepower. Grand Coulee Dam, which has been under construction for

"I would like to take the cellophane wrapping off of that word 'mechanized.'"

several years, contains enough materials to fill a double row of freight cars from New York to San Francisco and will develop 1,500,000 horsepower when completed. That is a lot of horsepower in anybody's language, but it is less than one third of the monthly production of aircraft engines in the United States before the war broke out. We were producing between 4,000,000 and 4,500,000 horsepower every thirty days.

There are now about 32,000,000 vehicles on the American highways. If we rate each of these at 50 horsepower, which is considerably less than the advertised value, we will find that there are 1,600,000,000 horsepower installed in automotive transportation alone. Now our 40,000,000 horsepower doesn't look so terribly big any more, and the 1,500,000 horsepower at Grand Coulee is hardly worth mentioning

In other words, the automotive industry is the greatest power-producing industry in the world.

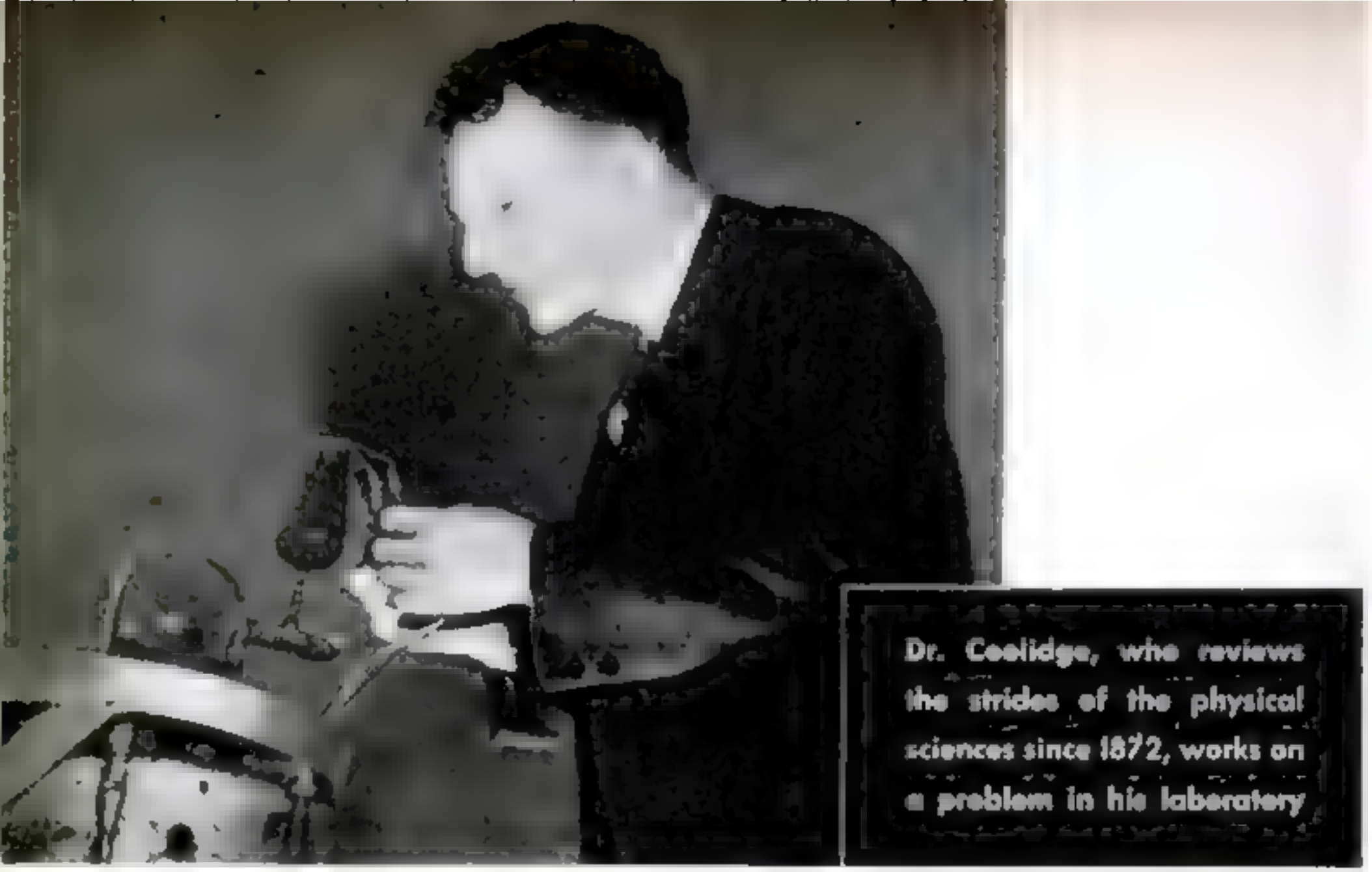
There is still a lot of room for improvement, however. The automobile is very inefficient in the use of fuels. Except in the case of the Diesel, we rarely get more than a ten-percent thermal efficiency from the engines and fuels we now have, and we cannot continue that sort of wastefulness forever. The reason I say it cannot continue is not that we are likely to run out of fuels, but that some bright young fellow is going to come along with an idea which will completely revolutionize the gasoline engine. That is one of the things that are going to come out of this war.

In the last World War, the best gasoline we had was 50 octane. With this gasoline we were able to run the Liberty engine, which was almost the same size as the modern Allison engine, at about 450 horsepower. Now we have 100-octane gasoline and are able to develop 1,200 horsepower or better from the Allison engine. The only thing that prevented our building an Allison engine in 1916 was the fact that we didn't have gasoline good enough to run it.

Today we need all of our 100-octane gasoline for aircraft fuel. For commercial engines, we are going to have to go back to lower-octane fuels than the 70 to 80-octane gasoline we were using when the war started. We are going to have to learn what we must do to run our engines on these poorer fuels, and when the war is over and we have all the 100-octane gasoline we need, we are really going to go to town. By that time, we will have learned so much that we will have engines built to use the large quantities of 100-octane fuels released from wartime use. The efficiency of all engines will be much higher than today, which will result in more miles per gallon.

"If someone had opened a travel office thirty-eight years ago and tried to sell tickets for an airplane flight across the ocean, he would probably have been considered crazy."

That may sound like a very rash prediction, but it is altogether possible. If someone had opened a travel office thirty-eight years ago and tried to sell tickets for an airplane flight across the ocean, he would probably have been considered crazy. It was only thirty-eight years ago that the first flight was *(Continued on page 220)*



Dr. Coolidge, who reviews the strides of the physical sciences since 1872, works on a problem in his laboratory

Seventy Years of Physical Science

By Dr. William D. Coolidge*

As told to James Stokley

TRULY, the 70 years of POPULAR SCIENCE MONTHLY have been momentous ones in physical science, for our concepts have undergone a complete change. From a feeling of completion, except for details, which prevailed then, we have come to realize that beyond what we know at present there is a vast region of knowledge, whose limits we never shall reach.

Seventy years ago the then new electromagnetic theory of light was a subject of much discussion. In 1864 the English physicist, James Clerk-Maxwell, had come to the idea that light is a wave motion, impelled by electric and magnetic forces. One conclusion from his theory was that a vibrating electric charge would set up electromagnetic waves, and that these would behave in a manner similar to light, traveling through space at the same speed of 186,000 miles per second.

Maxwell died in 1879, but in 1887, in Germany, Heinrich Hertz demonstrated these waves experimentally. A high-voltage electric spark from an induction coil was made to jump between two balls. To each ball was connected a metal plate. Many feet away Hertz placed another and shorter gap, with similar plates, but not connected to any induction coil. Yet when the big spark jumped across the first gap, tiny sparks appeared at the second. Further experiments demonstrated that this was a result of the waves Maxwell had foreseen, carrying energy across space, and that they could be subjected to the same effects of refraction, reflection, and interference as *(Continued)*

*Vice President and Director of Research, General Electric Co. Inventor of ductile tungsten, drawn-tungsten-filament lamp, and improved X-ray tube

Popular Science Introduced a New Type of Journalism

Edward Livingston Youmans published the first issue of Popular Science Monthly in May, 1872, only seven years after the end of the Civil War. Youmans founded a new type of journalism. Popular Science Monthly was the first magazine in the world to report in popular terms the news of laboratory and workshop — the discoveries of those scientists and engineers who have made America a great and powerful nation.

Perhaps you never have thought of Popular Science as being old Actually, there are only eight other magazines of general circulation that are older than ours. The reason that Popular Science seems always young is because it is *youthful in spirit* The secret of its success is that spirit We are Seventy Years old because we have always kept young

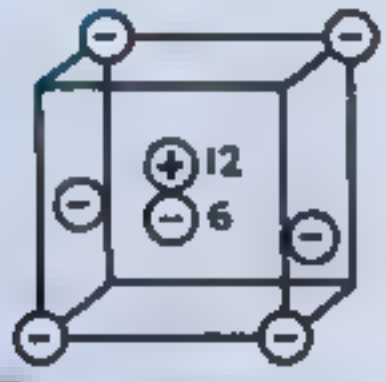
During its first Seventy Years the magazine participated in the industrial revolution . reported the automobile and the airplane as they remolded the transportation and the habits of our people . . . reported the growth of the movies, radio, and television — reported the discoveries of research laboratories and their development into those many practical applications that combat diseases, produce modern machines, and provide new and finer materials for construction and manufacture, Popular Science has become the News-Picture Magazine of Scientific and Industrial Achievement

Old and yellowed as are the pages of the 1872 issues, there is today something compelling about them all The first number contained 128 pages, all solid type except for a frontispiece of Samuel Finley Breese Morse and ten small illustrations in line The lead article was by Herbert Spencer, England's great writer on scientific subjects

Popular Science was then a fifty cent magazine — and its circulation was 12,000 Today, through the magic of modern production and editorial resourcefulness, Popular Science gives its readers vastly greater coverage of science, invention, and mechanics, with several hundred illustrations in every issue. And the circulation today is at its all time high — more than 700 000.

Popular Science today is reporting how the scientific and mechanical resources of the country are being mobilized to win this war It is doing its job in the manner of Youmans, but with the matchless facilities of 1942 And as we go on to the new world — the post war world of peace and reconstruction — Science will have other and infinitely bigger tasks Popular Science will report in text and pictures, with thoroughness and accuracy, the story of Science for the next Seventy Years.

These 70 Years Have Given Us:



ATOMIC RESEARCH

ELECTRIC LIGHT

AIRPLANE

X RAY

MOTION PICTURES

RADIUM

AUTOMOBILE

RADIO

TELEPHONE

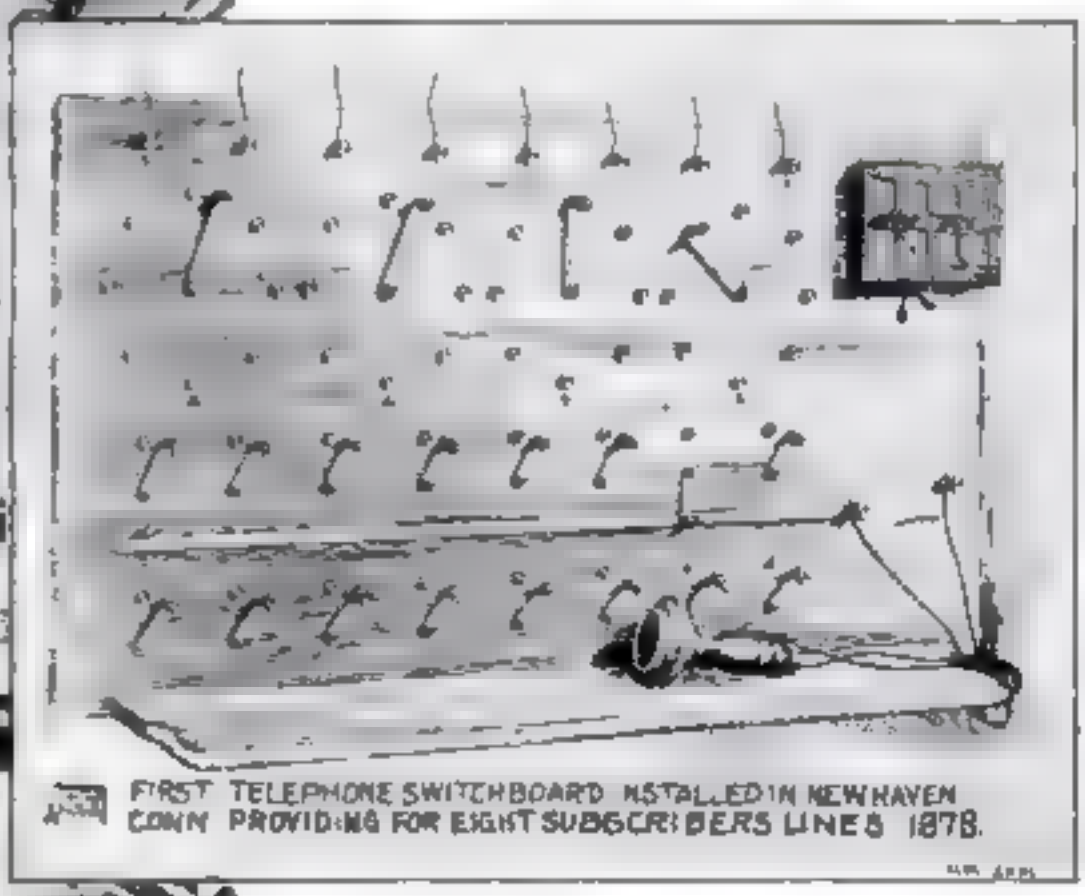
BELL'S FIRST TELEPHONE, reproduced in the model at left, is a far cry from the modern instrument below, with which one can talk over either of two outgoing lines or with three other persons on an interoffice phone system

light waves. Indeed, they were the same as light waves, except for their greater length.

At first, it was supposed that these Hertzian waves, again resembling light, would not be able to bend around the curvature of the earth. Despite this, it became evident that they might have some application for the transmission of energy across space. The first practical demonstration came in 1896 when Guglielmo Marconi, in Italy, used them for wireless communication. When, in 1901, he transmitted signals across the Atlantic, it seemed as if the earth's curvature had no effect. However, it proved that an ionized region of the atmosphere, at an altitude of 50-150 miles—the Kennelly-Heaviside layer — reflects and refracts the waves down again. This was the beginning of radio communication, and all its modern developments.

In the meantime, important advances were being made in another field. The similarity of behavior between the radio waves

SWITCHBOARDS have grown in size and complexity with the sixty-seven years of telephone development. The modern central office shown at left uses "crossbar" switches that barely move with calls



FIRST TELEPHONE SWITCHBOARD INSTALLED IN NEW HAVEN CONN PROVIDING FOR EIGHT SUBSCRIBERS LINES 1878.

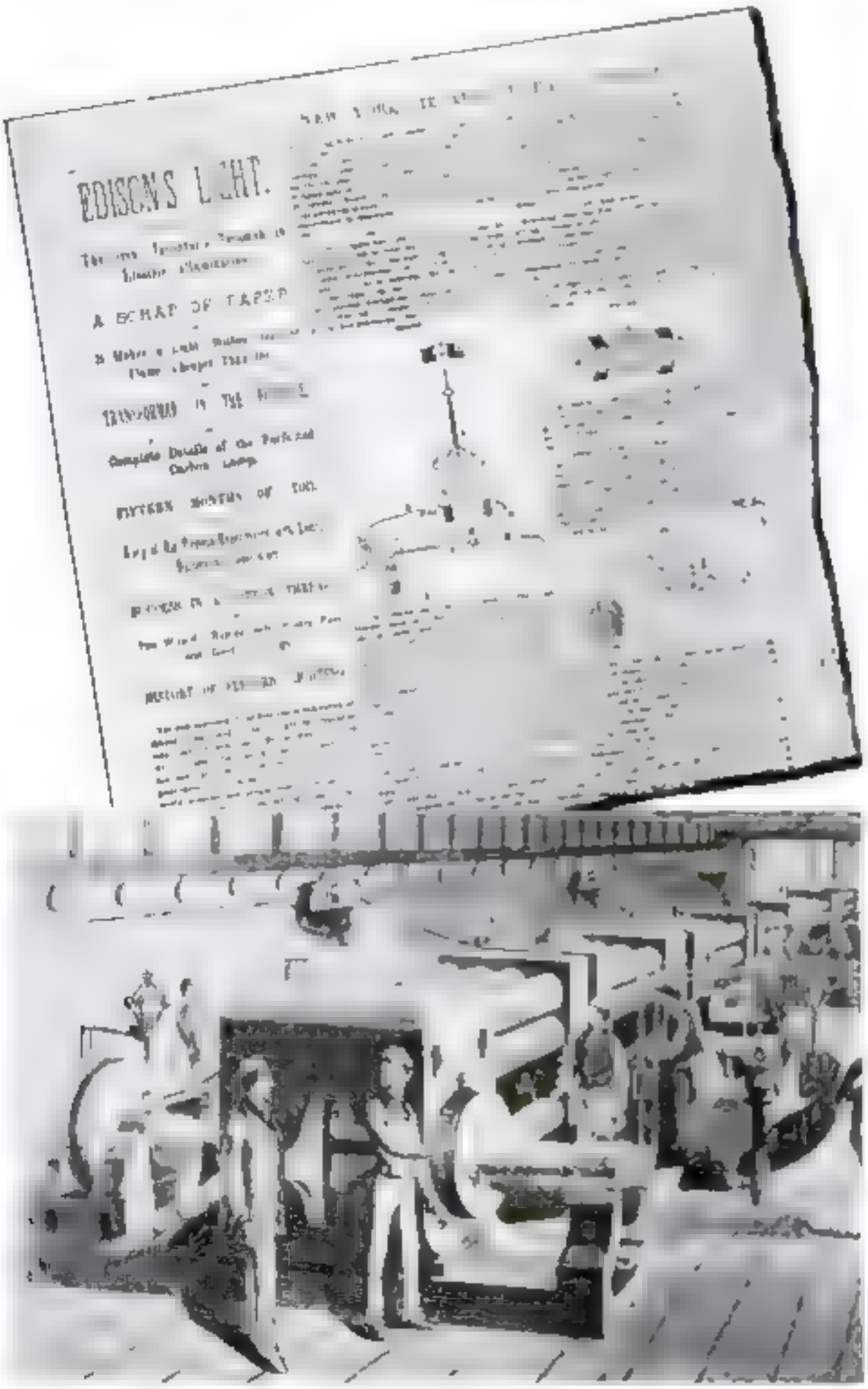
produced by electrical oscillations and light waves made it seem probable that the latter were caused by some similar oscillations on an atomic scale. Pieter Zeeman, in Holland, found in 1897 that when a beam of light passed through a strong magnetic field, the lines which appeared in the spectrum were doubled. Further, it appeared that the two parts of different wave length, into which the light was split, were polarized in different ways, depending on the relative positions of the beam and the magnetic field.

Shortly afterwards Zeeman's fellow-countryman, Hendrik A. Lorentz, showed the world how this could be explained only on the basis of the vibration of electric charges

10TH ANNIVERSARY Feature

as the origin of the light waves. And further, he concluded, much to the surprise of the scientific world, that the vibrating particles must have a ratio of their charge to their mass some 2,000 times as much as the ratio for a hydrogen ion, which had held the record.

This ratio of charge to mass, known as e/m, is an important one. Michael Faraday had come across it in his pioneer experi-


EDISON'S LIGHT.

A SCHEME OF TAPERS

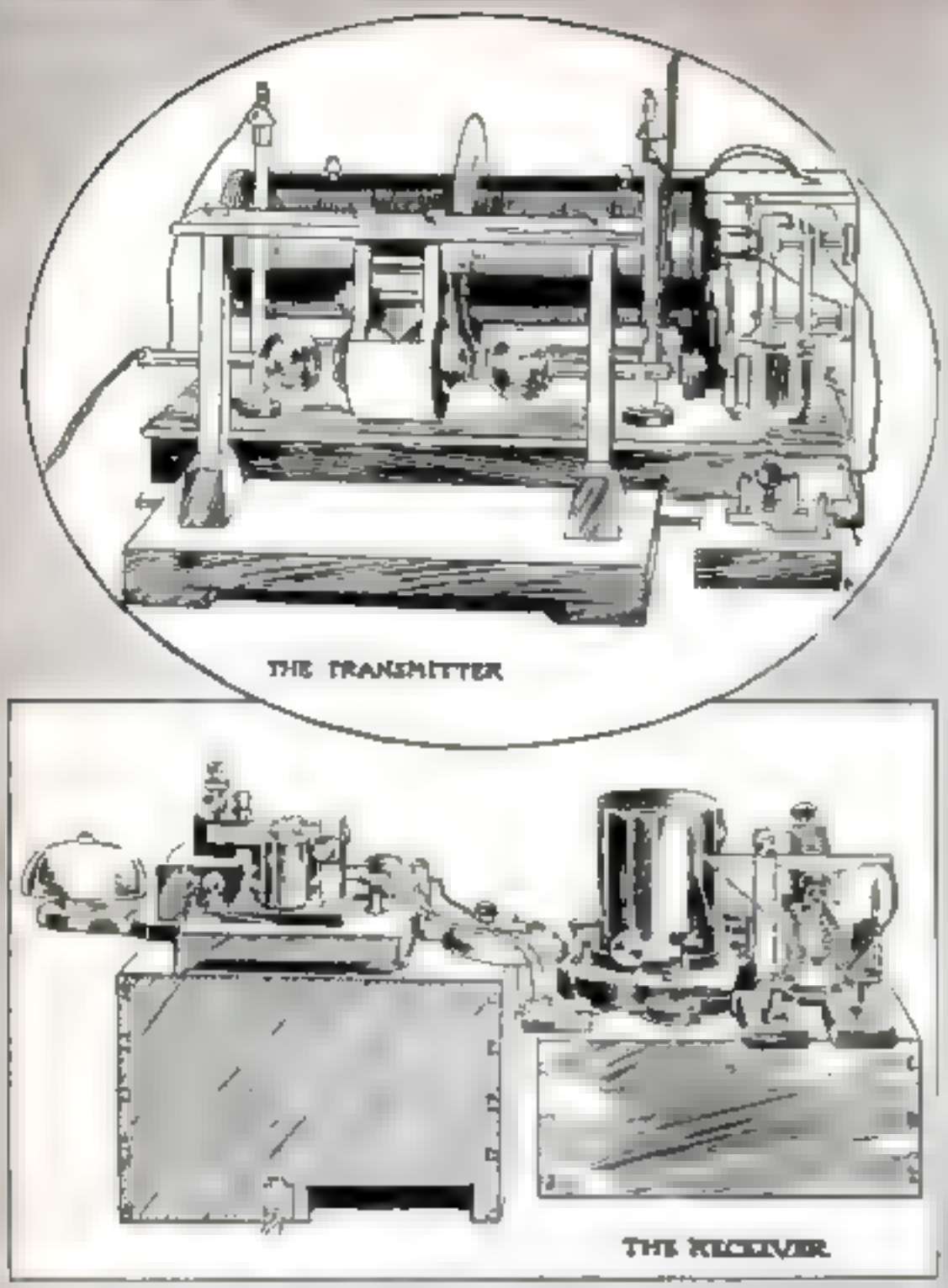
TRANSFORMED IN THE

Complete Details of the Perfected Uniform Lamps

SYSTEM SHOWING OF THE

FIRST ELECTRIC LAMP was a sensation when Edison produced it in 1878. The newspaper clipping, from the New York Herald, announces the first public exhibition of the marvel in 1879

ELECTRIC POWER industry was born on September 4, 1882, with the opening of the first Edison lighting station in New York. The dynamo room is shown in the contemporary drawing at the left. At the beginning, it supplied power to 14,000 lamps



THE TRANSMITTER

THE RECEIVER

RADIO. Marconi's first "wireless" transmitter and receiver marked the beginning of a new era in communication. The later development of radiotelephony brought into being the vast radio broadcasting and manufacturing industries we know today

ments on the decomposition of solutions of salts in water by the passage of current. He observed that the deposition of one gram of hydrogen at the negative electrode of a cell always requires the same total amount of electric charges. Assuming that each atom deposited at the electrode carries one unit of positive electricity, it was thus possible to determine the actual magnitude of this unit charge.

Sir William Crookes and others had been vigorously studying interesting things that happened in an evacuated glass bulb when a high voltage is passed through. From one of the electrodes, the cathode, there came rays, which could be bent by a magnet. They could make many substances glow while sealed in the tube; they could be focused on a thin metal plate and heat it to glowing, and through this effect could even turn a tiny windmill.

The direction they were bent by a magnet showed that these rays had a negative charge. At the Cavendish Laboratory, Cambridge University, J. J. Thomson, in 1897, measured the curvature of these rays by a magnetic field the strength of which was accurately known. These researches made it clear that the rays were streams of negatively charged particles, with e/m equal to nearly 2,000 times that of hydrogen. Since the particles were the same, no matter what gas was in the tube or of what material the cathode was made, Thomson announced that these "corpuscles," as he called them, were present in all matter. And now we call them "electrons."

Though the ratio of e/m could be measured, this did not give the actual value of e — the charge on the electron. C. T. R. Wilson, Thomson's colleague, found a method of doing this with minute drops of fog which condense on negative particles. Using it, Thomson himself in 1900 made one of the first good determinations. With many ingenious refinements and with skillful technique, R. A. Millikan, then at the University of Chicago, made a much more accurate determination in 1910.

Still further refinements made since then have led to extremely accurate determinations of the magnitude of this charge. This value is identical (but negative instead of positive) with that of the charge carried by a hydrogen ion in electrolysis. From this, and from a knowledge of e/m for the negatively charged corpuscles in a discharge tube, it is possible to calculate m, the mass of the electron. The value thus deduced is about 1/2,000th that of a hydrogen atom.

Not only did these streaming electrons prove of tremendous theoretical importance —they had practical value as well. When their nature was understood, they could be focused into a sharp beam and used as a weightless pointer for scientific instruments, as in the cathode-ray oscillograph tube. This in turn, developed into the kinescope tube for viewing television pictures. And among the most recent achievements of electron optics, as this science of handling electrons is called, is the electron microscope, which has extended many times the ability of man to observe minute detail.

Another electron development takes us back to the Menlo Park Laboratory of Thomas A. Edison, where, in 1883, he was developing his electric lamp. In one experimental lamp he sealed a small plate, con-

nected to the outside, in addition to the carbon filament which made the light. He found that when a galvanometer was connected between the wire from the plate and the positive side of the filament, a small current was detected. But, when the connection was made to the negative side, there was no current. After electrons were discovered, it became evident that they were responsible—they were emitted from the hot filament and, with their negative charges, carried the electric current across the space inside the lamp.

In the hands of J. A. Fleming, and later of Lee De Forest, this became the useful vacuum tube, such as is employed in our radio receivers. O. W. Richardson, a pupil of J. J. Thomson's, who later came to Princeton University, was able to work out the theory of this electron emission. It was further extended by the work in this laboratory of Dr. Irving Langmuir, who so improved the tubes as to make possible their use with high power output for radio transmission.

When an electron is torn from a neutral atom, something with a positive charge is left behind, and this something was also revealed by Thomson's work. If there is a hole, or "canal," in the cathode from which the electrons are streaming towards the positively charged electrode or anode, these canal rays will go in the opposite direction, and hence they are known as positive rays.

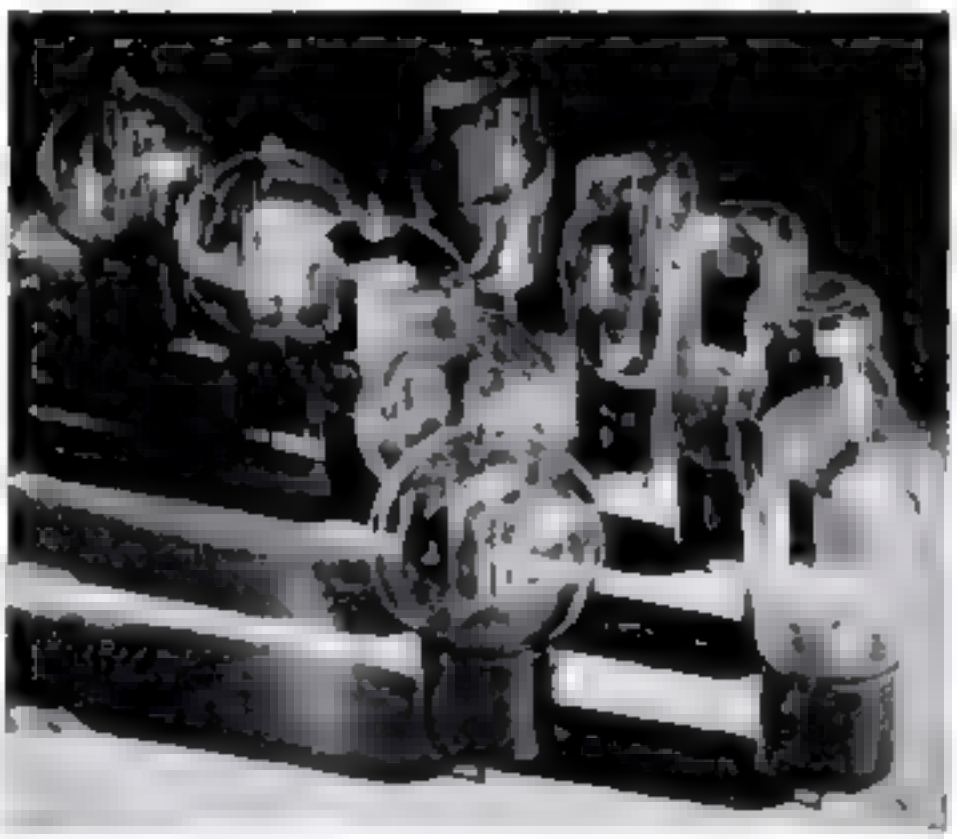
In the early 1920's, F. W. Aston, at Cam-

10TH ANNIVERSARY Feature

bridge, and later other experimenters, utilized these positive rays for very precise determination of the weights of atoms by means of an instrument called the mass spectrograph. First the positive ions are all set moving at the same speed so that their energy is proportional to the mass. When shot through a magnetic field, the lighter ones, with less energy, are deflected more than the heavy ions. In this way atoms that differ by only a millionth of a unit of mass can be distinctly sorted out.

One result of this work was the discovery that most of the chemical elements are actually composed of two or more types of atoms, which differ only in mass and are known as isotopes. For instance, chlorine, which according to chemists has an atomic mass of 35.46, is really constituted of two isotopes, one of mass 35 and the other of mass 37.

Of the 88 elements which occur naturally, about 280 isotopes are known, an average of about three for each element. Particularly important is "heavy hydrogen," discovered at Columbia University by H. C. Urey. It is made up of atoms twice as heavy, with mass 2, as ordinary hydrogen. In 5,000 parts of ordinary hydro- *(Continued on page 198)*

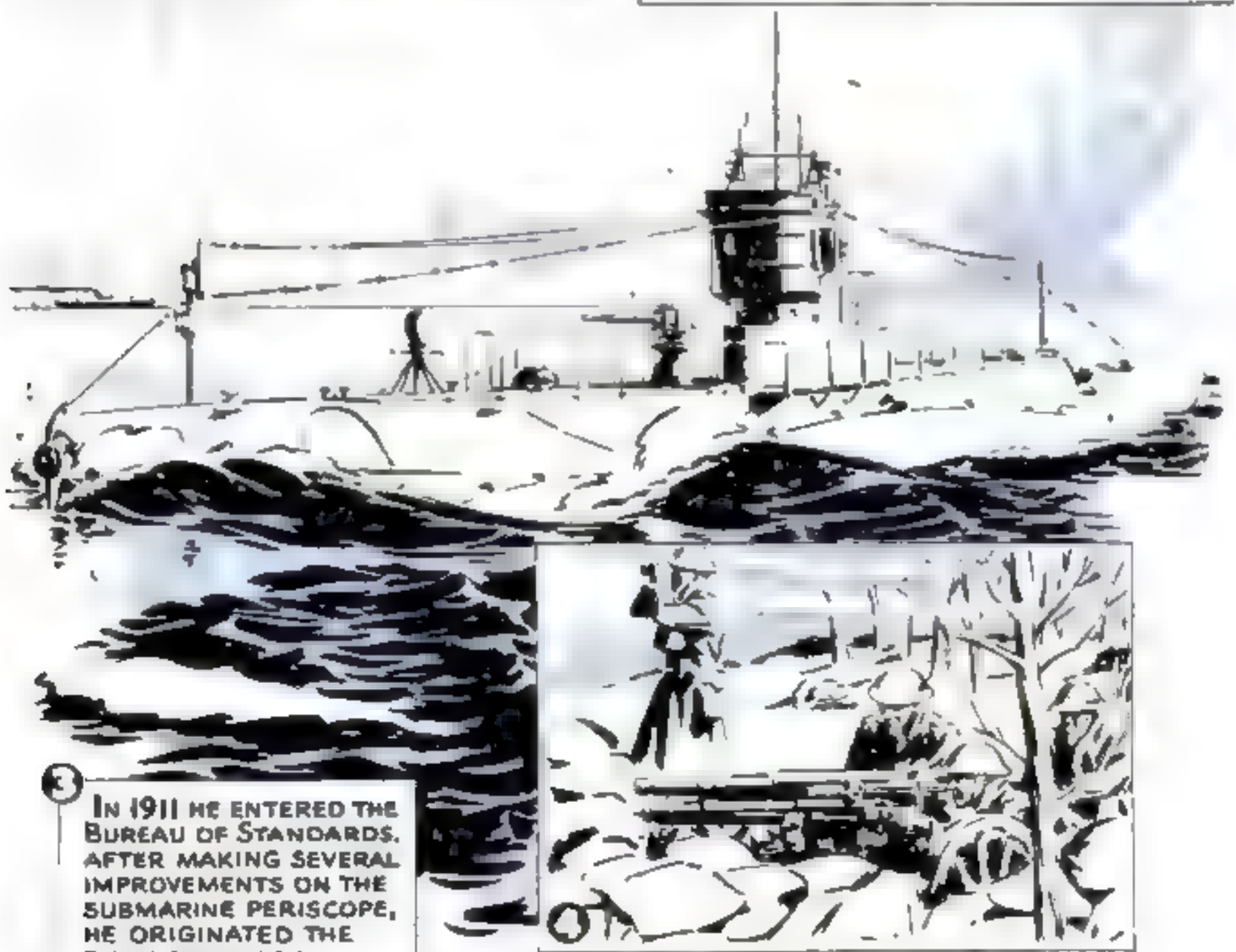


ELECTRON TUBES, first made laboriously by hand, are now manufactured in large quantities at low cost, and in an ever-increasing variety of types for special uses. At the right, a worker is assembling a cathode-ray oscillograph tube of the kinescope type used in television, an outgrowth of radio that promises to create still another mammoth industry

Here's My Story

DR. EDGAR D. TILLYER, RESEARCH DIRECTOR FOR THE AMERICAN OPTICAL CO., STARTED HIS CAREER IN A HOME WORKSHOP. AS A YOUTH HE USED HIS SPARE TIME INVENTING HOUSEHOLD GADGETS

AFTER COLLEGE, TILLYER BECAME AN ASTRONOMICAL OBSERVER AT THE NAVAL OBSERVATORY. WHILE WORKING THERE, HE IMPROVED THE CLOCK-VAULT TEMPERATURE CONTROL, WHICH MADE TIME MORE ACCURATE IN THE U.S.



IN 1911 HE ENTERED THE BUREAU OF STANDARDS. AFTER MAKING SEVERAL IMPROVEMENTS ON THE SUBMARINE PERISCOPE, HE ORIGINATED THE FIRST STANDARD SPECIFICATIONS FOR NAVAL PERISCOPES AND GUN SIGHTS

DURING THE LAST WAR, TILLYER MADE IT POSSIBLE FOR THE U.S. TO MANUFACTURE TELESCOPIC SIGHTS FOR THE FRENCH 37-MM BY SUBSTITUTING DOMESTIC OPTICAL GLASS FOR THE FRENCH TYPE IN WHICH UNOBTAINABLE BARIUM WAS USED

THE CAREER OF
DR. EDGAR D. TILLYER

BEGINNING IN 1906, DR. TILLYER WORKED ON A LENS WHICH COULD BE CORRECTED FOR MARGINAL ASTIGMATIC AND FOCAL ERROR, AND MADE AT A MODERATE PRICE. AFTER 18 YEARS HE SUCCEEDED IN 1924

AN AUTOMATIC HEAT SCREEN FOR MOTION-PICTURE PROJECTORS IS ANOTHER IMPORTANT TILLYER INVENTION. THE SCREEN PREVENTS THE FILM FROM BEING BURNED WHEN THE PROJECTOR IS STOPPED

BOTH ARMY AND NAVY FLYERS WEAR GOGGLES WITH DEEP CURVE LENSES INVENTED BY DR. TILLYER. THEY ARE SAID TO ELIMINATE HEADACHE AND IMPROVE VISION

ALTHOUGH DR. TILLYER SPENDS A FULL DAY IN HIS LABORATORY, HE STILL FINDS TIME FOR AMATEUR PHOTOGRAPHY, A FAST GAME OF BADMINTON, OR A BACK-COUNTRY FISHING TRIP

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Human flies, swinging dizzily from bosuns' chairs (arrow) and a sliding platform at far end, wash the dam's face

Coulee Dam Marks Time As Workers Clean It, Install Light Plant

WAITING for aluminum-plant construction to catch up with its mighty power, Grand Coulee Dam on the Columbia River, Washington, has removed one of the major bottlenecks of airplane production. Last year, its electrical output could have produced enough of the metal for 500 four-engine bombers or 2,800 fighter planes. Now a second 108,000-kilowatt generator has been installed, and a third is scheduled to be in place about the time this is printed—supplying a total amount of power sufficient for a city the size of Pittsburgh, Pa. Odd jobs about the gigantic structure have included "washing its face" to remove blemishes from the dam, and installation of a huge storage-battery plant to provide the power house with emergency lighting.

Two of the 108,000-kilowatt hydroelectric generators, largest ever built, are already installed, and a third will soon be ready to help deliver power to war industries of the Northwest

Power may fail even at Grand Coulee, so this array of storage batteries stands by to furnish current for emergency lighting

ARMY AIR CORPS BUILDS

400-MILE-AN-HOUR WIND TUNNEL

Air scene at the U. S. Army Air Corps' new $2,500,000 wind tunnel at Wright Field, Dayton, Ohio. The gleaming aluminum-painted exterior of the tunnel reflects heat that would vary air temperature and density

UPSIDE down, in a building with windows that never open, hangs a super-streamline model of a future American fighting plane. From a 20-foot orifice in a giant cone, an air blast roars past it at 400 miles an hour and with 25 times the force of what the Weather Bureau calls a hurricane. Straining at three pylons that hold it, the teetering craft records its own behavior on a moving chart in an overlooking control room. The time is after midnight, and the scene is the Army Air Corps' new $2,500,000 wind tunnel at Wright Field, Dayton, Ohio.

Believed unsurpassed, this flight laboratory will play a fundamental role in maintaining American air supremacy. For behind the constantly accelerating speed and performance of British Spitfires, German Messerschmitts, and U. S. warplanes stands the deadly rivalry of wartime research teams working at top speed.

What is the best shape for an airplane wing? A fuselage? Where can air drag be eliminated? Will a plane be stable, and maneuverable? How much load can it carry, in men, fuel, armor, guns, and bombs? In short, how can the enemy's latest model be outclassed? Engineers cannot figure it all out on paper. Questions must be answered in the wind tunnel, where flying conditions are reproduced, and sensitive balances register unpredictable forces such as lift and drag acting on a proposed design.

By keeping the model stationary, and blowing air past it, results almost identical with actual flying are obtained. The Wright Field wind tunnel permits experiments with good-sized plane models up to 15 feet in span, full-

scale fuselages, engines and propellers mounted on nacelles, and airplane wings.

Biggest of its kind ever built, the 40,000-horsepower alternating-current induction motor that turns the propelling fans can go into action only after advance notice to the power company so that, if necessary, current may be tapped from other cities as far away as Cleveland. Through a 16-inch shaft resembling the propeller shaft of an ocean vessel, the giant motor spins a pair of 40-foot fans, both in the same direction. Their hubs fit into metal fairing, shaped oddly like a dirigible, at the center of the tunnel.

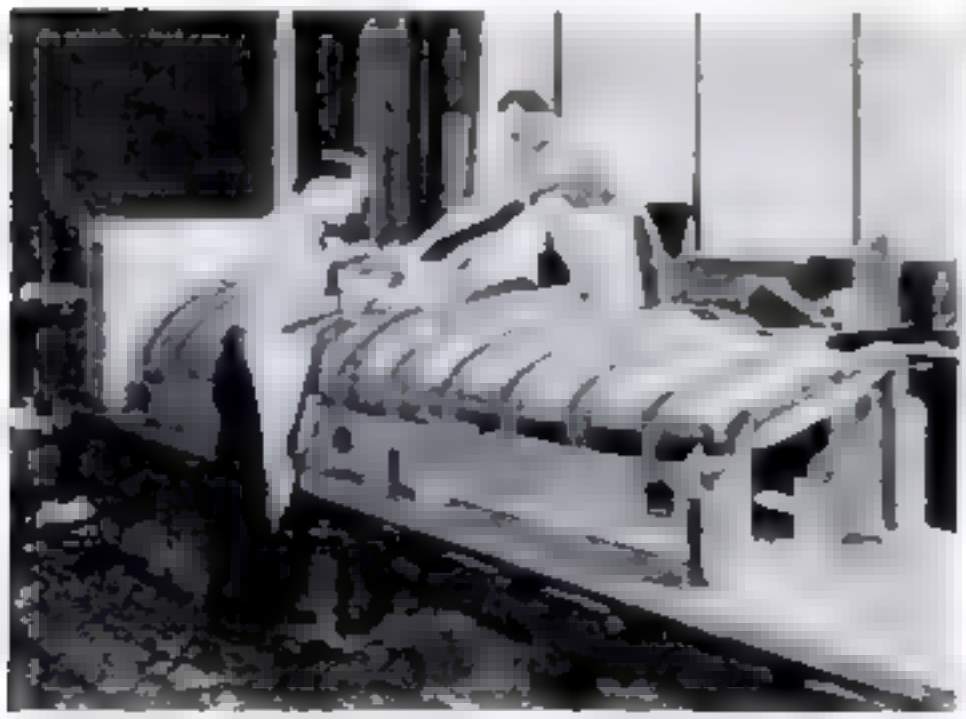
Nothing like these fans had ever been built, so the propeller laboratory at Wright Field tackled the job. Under the direction of Major Edward M. Robbins, chief of the engineering shops, a crew of 36 carpenters and pattern makers fashioned the wooden blades—sixteen for each fan, and eight spares.

A complete blade with attaching parts weighs 1,500 pounds. To make each one, 42 layers of prime Washington spruce were cut, assembled, and joined with casein glue in a special jig press to form a solid laminated block. Pneumatic spoke shaves of Wright Field design cut off rough corners and shaved the blocks to a size over which master templates could be fitted. Riding on its ribs, a rotary saw cut vertically into each blade, marking the depth still to be removed. Shape was attained with spoke shaves, hand planes, and sandpaper. As the last step, a block at the base was shaped for attachment to the rim of the metal hub. How securely a blade needs to be anchored may be gathered from the fact that, at full speed, centrifugal force tends to tear it loose with an outward pull approaching 394,000 pounds, comparable with the maximum tractive effort of a powerful locomotive.

So that the high-speed air stream will make the 616-foot circuit of the wind tun-

To make one of the 1,500-pound fan blades, 42 layers of spruce (right) are glued together in a jig press (left) at 2,000,000 pounds pressure

With a pneumatic spoke shave developed at Wright Field, rough corners are cut off and the block is shaved down so master templates will fit over it



Riding the ribs of the master template, a rotary saw cuts vertical marks at one-foot intervals to guide workmen in finishing the blade

Sandpapered and finished with aluminum paint, blades resemble airplane wings. Final step is to shape base blocks and attach anchor parts

nel with the least possible resistance, upright curved vanes guide it around each of the four corners. For the same reason, sections of the tunnel have been joined by welding instead of riveting and the joints sanded to perfect smoothness.

Just before the recirculated air strikes the fans, fixed "pre-rotation vanes" start it gently whirling. This eases the shock with which the fan blades boost it on its way. Other vanes straighten out the air stream, removing the "twist."

Both the diameter of the tunnel and the speed of its wind stream vary along its length. Thus a comparatively modest gale in the large section where the propellers operate becomes nearly a seven-mile-a-minute jet as it spurts from the constricted nozzle in the test building and leaps a gap to the opposite outlet

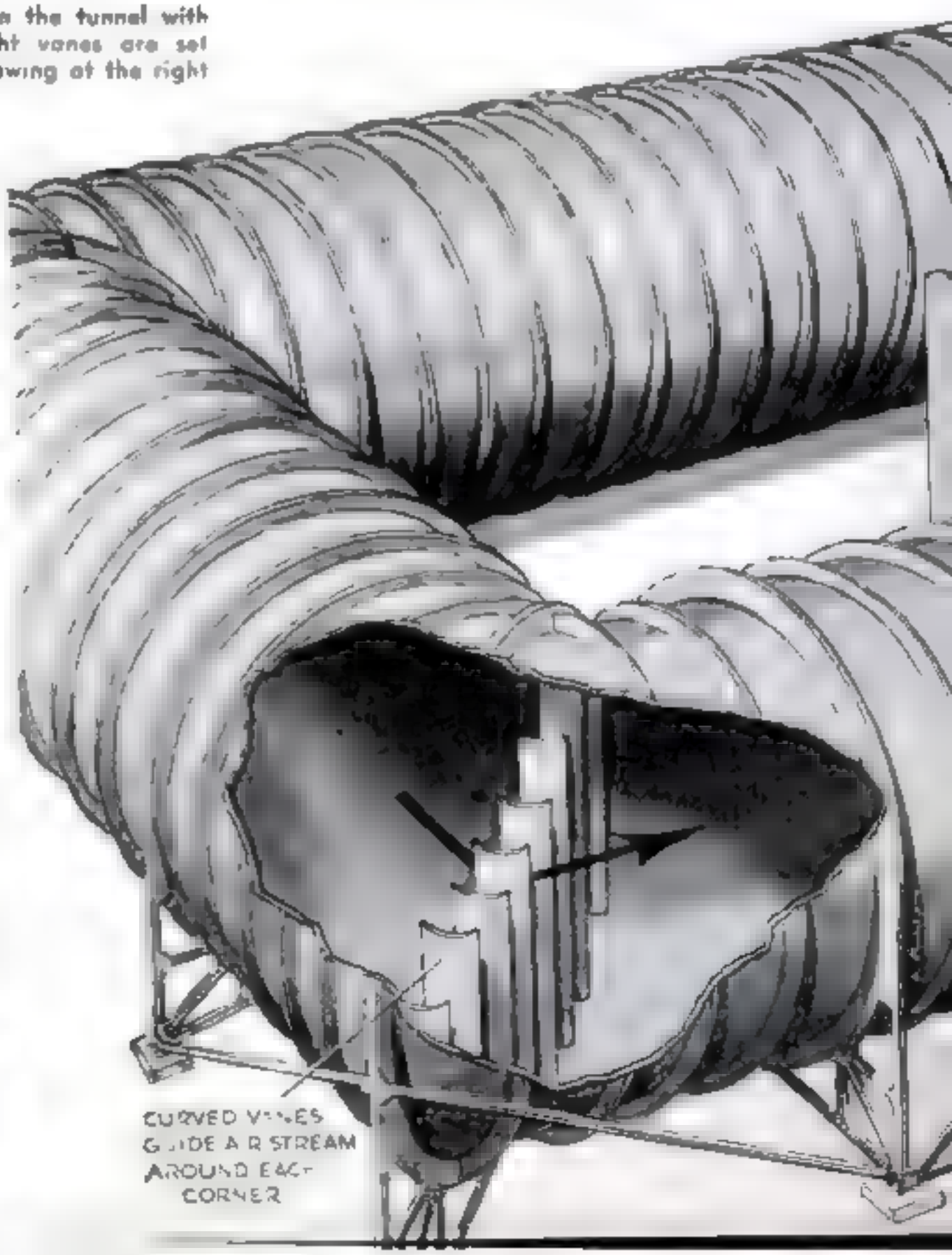
By tending to carry along the surrounding air, the passing stream has the curious effect of lowering the air pressure in the test chamber itself to about two pounds per square inch less than the outer atmosphere. Hence, the windows that admit daylight are tightly sealed against inward air leakage. Persons enter and leave through an air lock. Hand valves permit passage through the lock's two outward-opening doors; without them, it would require a pull of several thousand pounds to break the suction.

When a test is to be made, a rising stage aids in suspending a plane model from three "load members" in the gap between nozzle and outlet. The model is mounted upside down, simply because balances in the scale house overhead happen to read lifting force in a downward direction. A right-side-up or inverted position makes no difference as far as behavior is concerned.

Operated from the control room, the mechanism of the mounting turns the plane at any desired angle to the air stream, simulating an airplane following a fixed course through wind from various directions. The telescoping load members also enable the tilt of the plane to be varied.

As the model reacts to the blast, connecting members actuate the scales that register lift and other factors. A mechanical brain called an integrator combines related forces acting on the plane. For instance, if its nose tends to dive and its tail to rise, these ac-

To help the racing air take the turns in the tunnel with least possible resistance, curved upright vanes are set at corners, as shown in the cut-away drawing at the right



tions give a single reading, which an engineer calls the "pitch moment."

During the months and years to come, this procedure will take place innumerable times. To date, tests in smaller tunnels have yielded the famous N.A.C.A. engine cowling, wings that carry more load or require less horsepower at high speed, better location of engine nacelles in multi-motored planes, and reduced skin friction for greater speed. Equally important discoveries may be expected at Wright Field. No doubt the first announcement will be their devastating use in actual combat with our enemies.

GLAND STUDIES SHOW Why We Behave As We Do

WHAT is the difference between a winning and a losing race horse? Are lions really "lion-hearted" and hares "hare-brained"? What prospect is there of a future race of mental or physical supermen?

By collecting the glands and vital organs of 3,734 men and animals, in expeditions totaling 100,000 miles, Dr. George Crile, noted surgeon of Cleveland, Ohio, and his collaborator, Dr. D. P. Quiring, have found answers to questions like these. Under African sun and northern lights of the subarctic, Dr. Crile and his associates weighed the body, brain, thyroid gland, adrenal glands, and heart of each specimen, with instruments ranging from an analytical balance to a Chatillon scale on which the largest trophies of the hunt were placed in sections. He was looking for any possible relation between an animal's traits and the size of these organs.

When all the observations were set down for comparison, long-mysterious "whys" of the animal kingdom fairly sprang from the thicket of tabulated figures. In the Museum of Intelligence, Power, and Personality, at Cleveland, mounted animals and lifelike models of their organs now illustrate striking conclusions of the fact-finding quest.

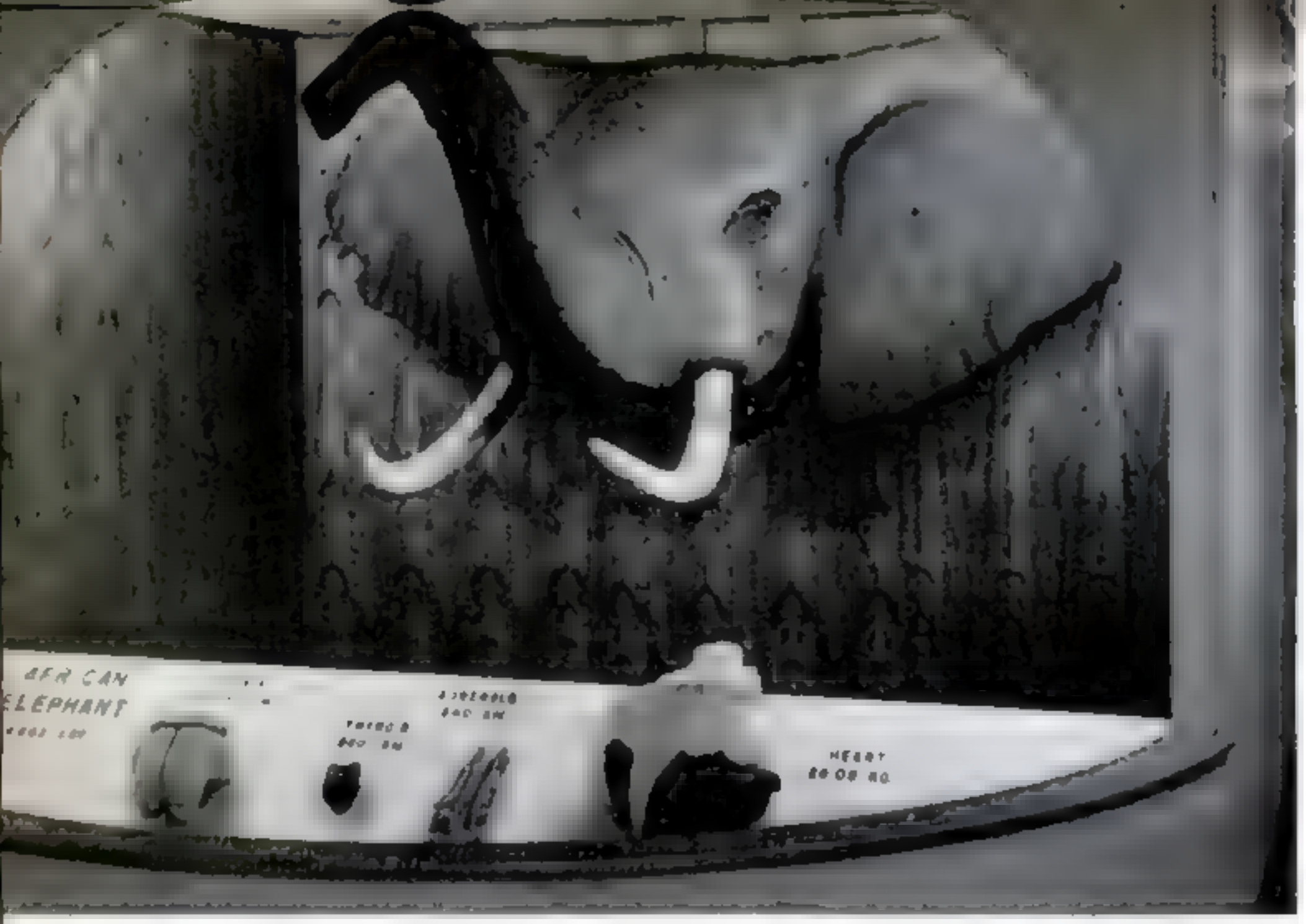
Its thyroid gland governs an animal's sustained energy, the findings show. This gland, coöperating with the brain, provides the constant heat in muscles and tissues that maintains the body of an arctic whale at 98.6 degrees—the temperature characteristic of warm-blooded animals. It supplies the tireless, long-distance running energy of the timber wolf and the rest of the dog family. Likewise, it enables a frightened deer or antelope to outrun a pursuer of less endurance. In these animals, the thyroid gland nearly equals or exceeds the adrenal glands in weight.

Adrenal glands, in contrast, release a short burst of emergency or "crisis" energy. They energize the blitzkrieg attack of the cat family, and the dash to safety of squirrels and rabbits. They also provide emergency power for an elephant to extricate itself from a bog, or ascend a slippery bank. Among these animals, the adrenals considerably outweigh the thyroids.

Here is an illuminating explanation—the relative size of thyroid and adrenal glands—for the varied behavior of different animals. "Are you a man or a mouse?" takes on new meaning. Adapted to their insecure life, mice possess adrenal glands nine times the size of their thyroid glands, making them the most highly adrenalized animals known. At the other extreme, predominance of the thyroid gland reaches its highest development, 2½ times the size of the adrenals, in

With model and dissecting tools, Dr. Daniel P. Quiring, associate of Dr. George Crile in his study of the glands and vital organs of animals, shows how the heart of a manatee was explored for new data

ALLIGATOR AND LION. Closely matched in weight—but what a difference between the sluggishness of the swamp dweller and the fulminating energy of the king of beasts! Their glands and vital organs, below tell the story. The highly developed nerve network of the lion's coeliac complex is seen interconnected with the large adrenal glands for producing explosive bursts of energy, as in leaping on its prey



AFRICAN ELEPHANT. Huge bulk with limited surface makes keeping this animal cool a problem. Small thyroid gland keeps down heat production; large adrenals supply emergency power. Collected in equatorial Africa, this elephant weighed 14,640 pounds. Brain weight, 12½ pounds; heart, 57½ pounds

man. Master of all other animals, he faces danger only from his own kind.

Compare, as one museum exhibit does, an alligator and a lion closely matched in weight. Both are carnivorous animals, but the likeness ends there. Their glands tell a story as plainly as the plans for a tractor engine and an airplane motor. Cold-blooded, the low-powered reptile has only a small thyroid gland; protected by armor, it has even smaller adrenals. (Weights shown in photos are marked in grams and kilograms: a gram equals about 1/28 of an ounce, and a kilogram, 2.2 pounds.) The weight of its half-ounce brain just about equals that of a hare. For the hare, this is a creditable size; less can be said for the 450-pound alligator, just 100 times as big.

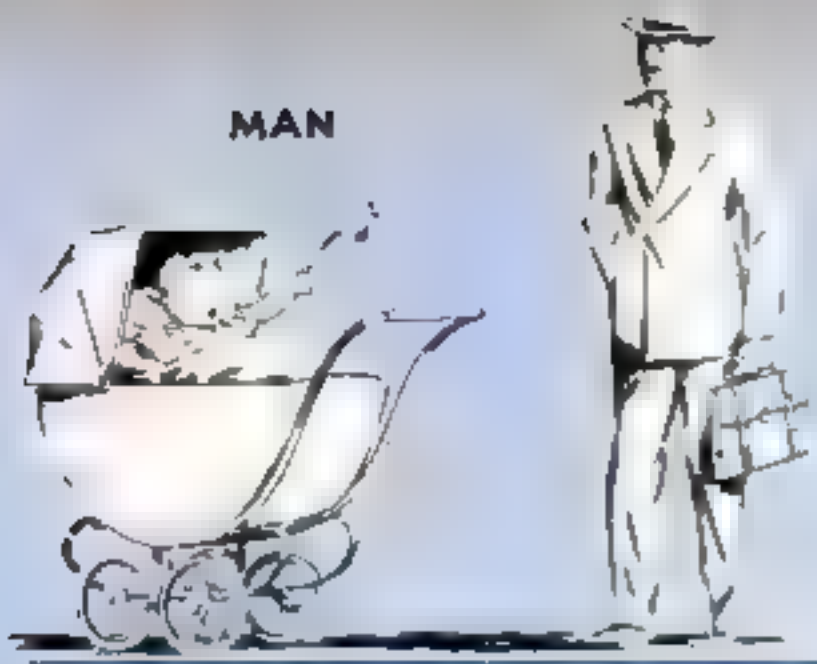
Note the much larger glands of the 430-pound king of beasts—especially the adrenals, and their associated network of nerve fibers and centers called the coeliac complex. In no other animal, nor in man, is this nerve hook-up so highly developed. To release the most fulminating animal power known, crisis energy from the adrenal-coeliac system galvanizes millions of brain cells, pours sugar from the liver into the blood stream, and slams heart and lungs into high gear. More like an explosion than a physical performance, the lion's incredibly high and long leap upon its prey is now understood for the first time.

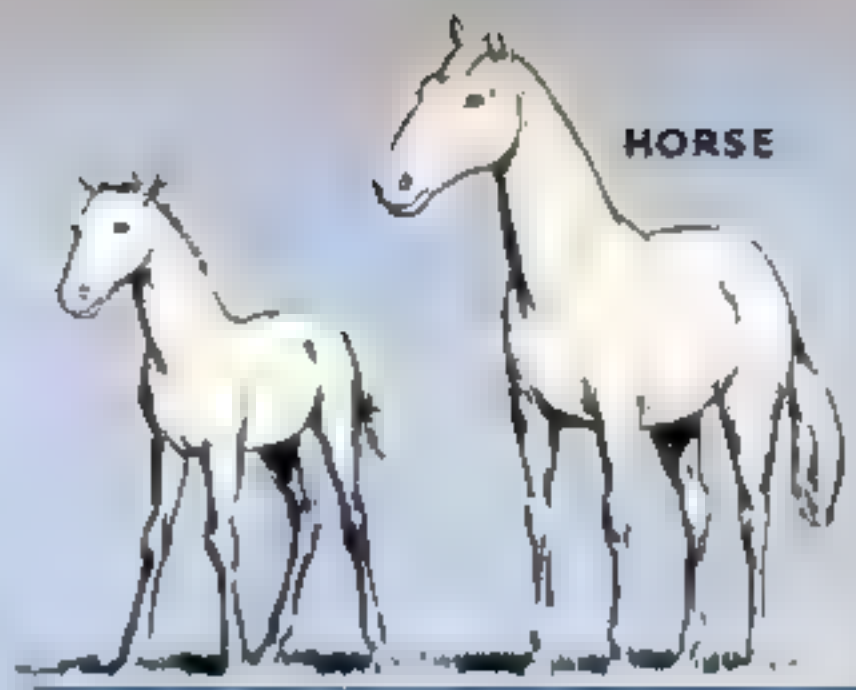
Four times the size of a lion's heart is that of a thoroughbred horse. Organs of Equipoise, famous Kentucky stallion, furnish a blueprint of a great race horse. One of the swiftest animals known, he was geared for a short dash to exhaustion. His adrenal glands were more than a third larger than his thyroid.

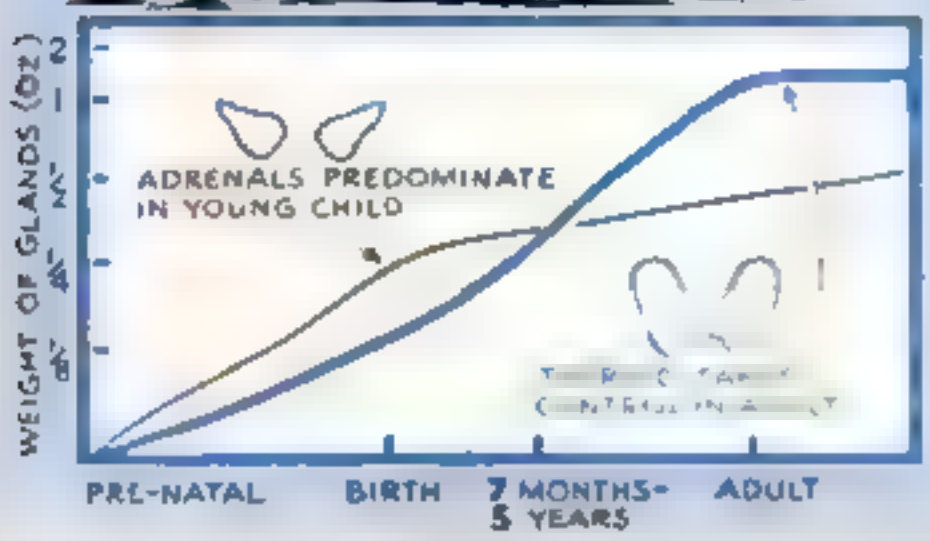
A draft horse, built for pulling loads, does not require nor possess the adrenal-gland dominance of an Equipoise. By a small margin, the thyroid gland predominates in a typical Percheron.

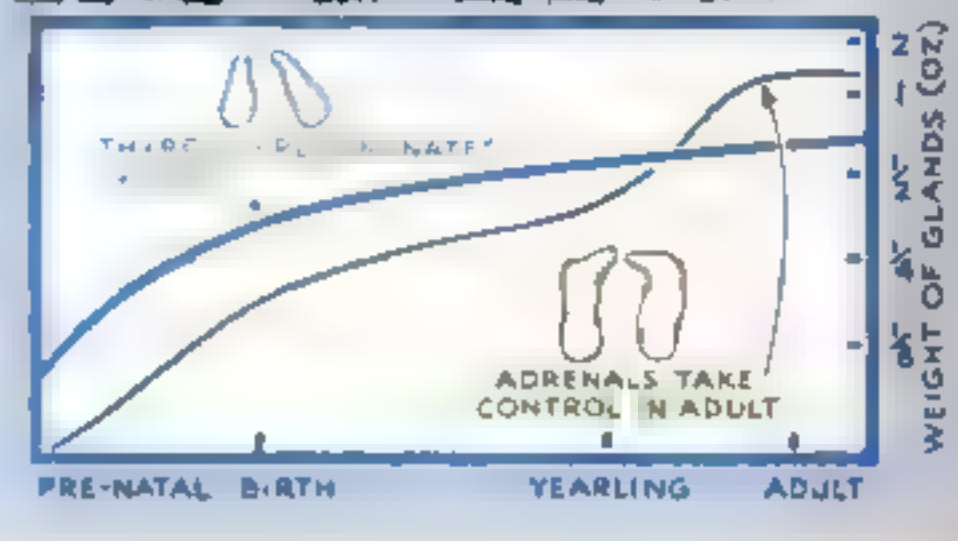
But consider the case of Brown Eyes, a promising thoroughbred of as distinguished a line, and as carefully trained, as Equipoise. To the dismay of her owner, she developed a temperament so excitable that she could not even be started in a race. The mystery was solved when she proved to have abnormally large adrenal glands, the biggest of 231 horses examined by Dr. Crile.

There is an interesting coincidence, if not more, in one of the human records of the museum collection. A 25-year-old gangster



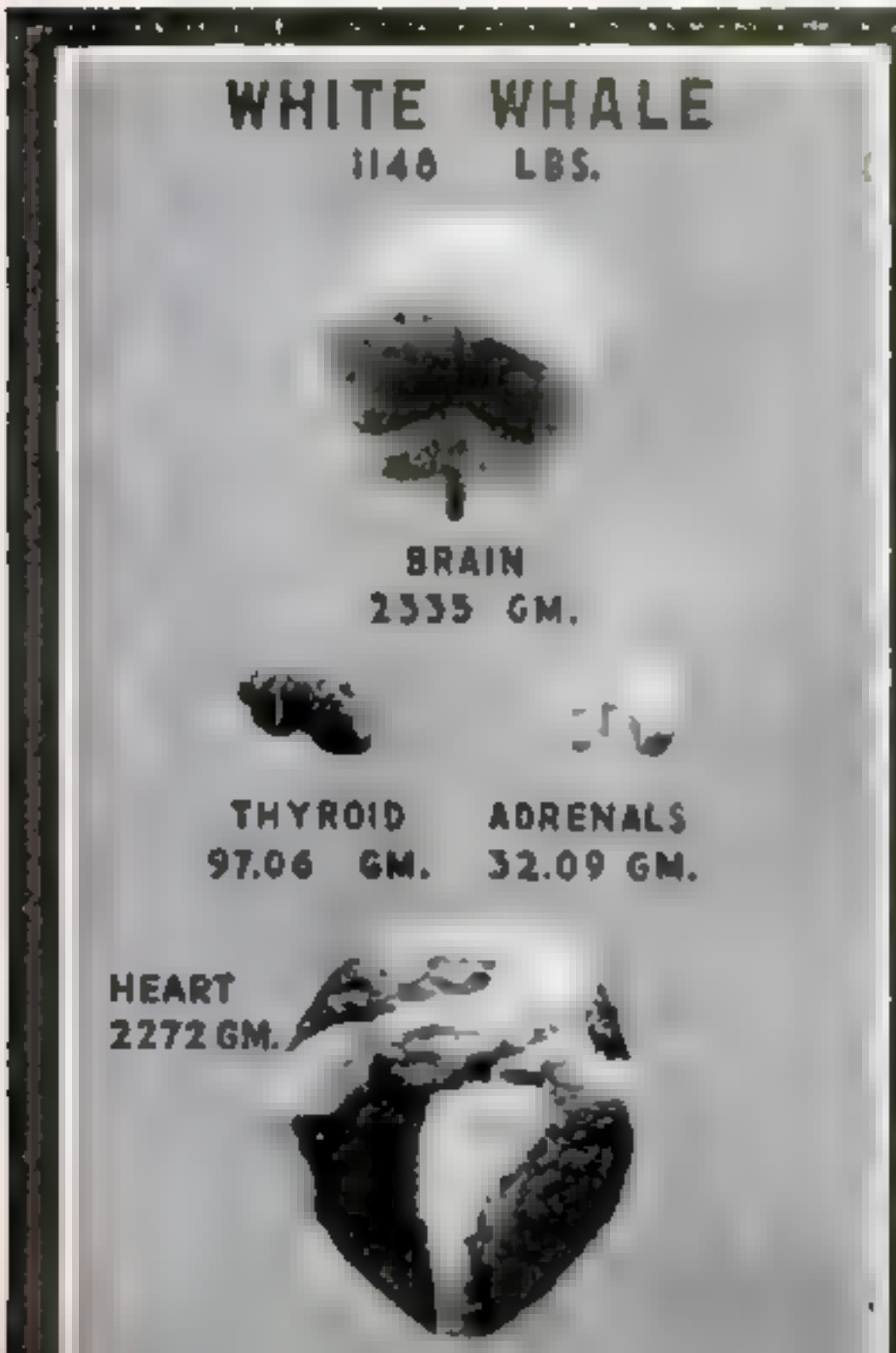


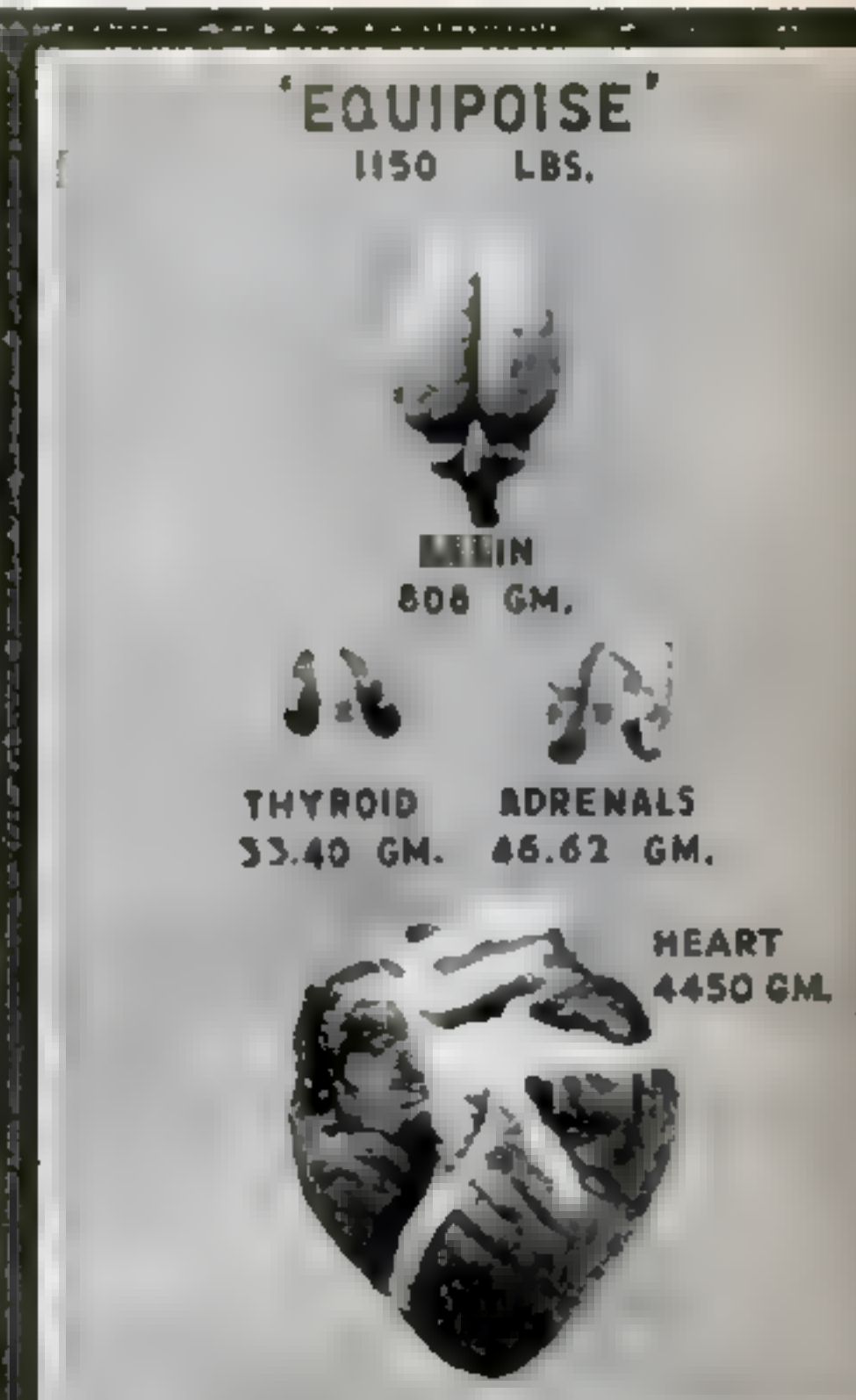




NEW CLEWS TO THE PAST? Man's thyroid, horse's adrenals, gain ascendancy with age. Since individuals retrace evolution of species, glands development curves suggest that man's remote ancestor was a highly adrenalized tropical animal, while the horse is descended from a creature in a cold climate.

WHALE AND HORSE. Large brain, thyroid and heart, needed to maintain body heat in icy seas, testify to the arctic habitat of the whale. By contrast, Equipoise, famous Kentucky race horse, has larger adrenals than thyroid. Of all animals of its size, a thoroughbred horse is the most "lion-hearted"





was convicted of murder. He had been as incorrigible in home and school as was Brown Eyes in her training. Similarly, the gangster's adrenal glands were found to be twice as large as those of a normal human being. By this standard, he was more of a wild animal than a man.

That both men and horses pass through "dual personalities" in the course of their lives came to light when specimens of various ages were compared. Before and for a few years after birth, the adrenal glands of a normal child predominate over its thyroid gland. Later, the thyroid overtakes and passes the adrenals. In the case of a thoroughbred horse, just the opposite occurs—first the thyroid, and then the adrenals, predominate

Is this a new clew for scientific delvers into the past? Since it has long been recognized that the early development of an individual retraces all the history of its evolution, the evidence points to a thyroid-dominant ancestor of the horse, indicating its origin in a cold climate. Conversely, it suggests man's remote ancestor as a highly adrenalized animal of tropical habitat. By other reasoning, evolutionists link early man to some animal like the tree-dwelling lemur. An African lemur collected by Dr. Crile, with adrenal glands eight times as large as its thyroid gland, might seem to afford some support to this interesting hypothesis.

Nitrogen compounds in protoplasm put a limit on the further development of the brain and glands in man. At higher body temperatures, these would blow up like nitro explosives, causing a heat stroke

How does man's brain compare with an animal's? It's nowhere near the largest, the 18-pound brain of a great whale. Nor does it rank highest in proportion to body weight. A song sparrow's brain represents more than five percent of its total weight; a mouse's brain, about three and a half percent; and a man's brain, only two and a half percent. But there remains an all-important distinction.

In all animals from insects to mammals—except man and the higher apes—brain size corresponds exactly to need for heat, for power to circulate the blood, and for other vital functions that science lumps together under the name of basal metabolism. This has even been reduced to a formula by Dr. Crile and Dr. Quiring—it takes just one gram of brain to stimulate the production of 12,115 small calories of heat or equivalent energy in 24 hours. By this rule, a man's "animal requirements" would be nicely taken care of by a brain of less than five ounces. Actually an average human brain weighs about 3¼ pounds. To a large extent, the big difference corresponds to man's unique ability to think.

Will nature evolve a "superman," by further development of the human brain and its thyroid and adrenal teammates? Apparently the limit has already been reached, or closely approached. With other animals, man shares the danger of heat stroke—a phenomenon akin to sunstroke. Protoplasm of his cells, especially those in his brain, contains sensitive compounds of nitrogen. At normal body temperatures they break down constantly and harmlessly, releasing heat and power. But if an animal cannot eliminate surplus heat, its body temperature rises to a point where the nitrogen compounds, like nitro explosives, literally blow up. For human beings, the safety limit is 108 degrees. A fraction of a degree more, and the symptoms of heat stroke occur—mental confusion, stupor, and coma or death. This sets the ceiling for the energy-controlling organs on which intelligence and power depend.

Other speed limits are apparent in "energy diseases" peculiar to civilized man. Most of us have heard of mental disorders, high blood pressure, and heart disease, caused by overactivity of one gland or another; and of remarkable cures effected by partially or wholly removing the troublesome gland. One of the first practical applications of Dr. Crile's work has been a fuller understanding of the principles underlying these delicate operations. Better yet, the new knowledge makes it possible to detect tendencies toward gland disorders in adults and children in time to take preventive measures.

Far from considering his studies completed, Dr. Crile regards them as only fairly begun. But the monumental array of information so far available suggests bypaths to which a goodly number of research experts may well devote their life work.—ALDEN P. ARMAGNAC.

HOMEMADE PLANE DETECTOR

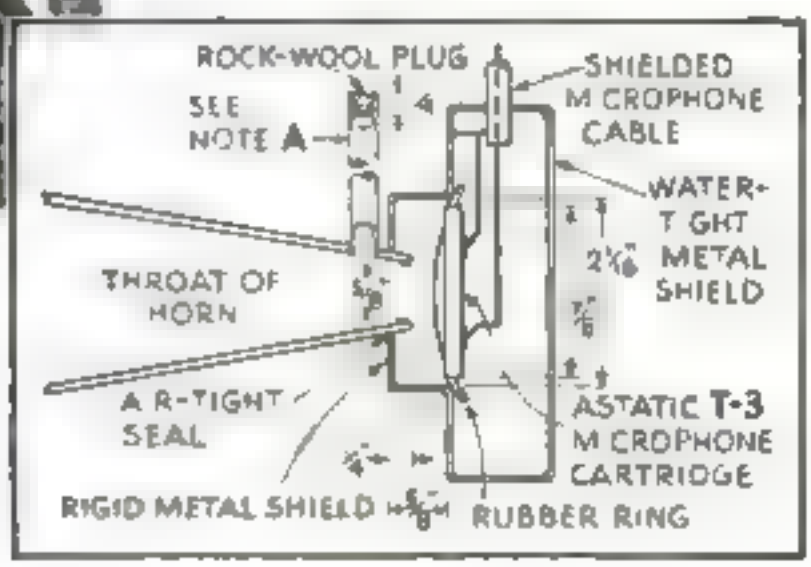
"Ear" for Civilian Defense Costs Less Than $50 to Build

TO PROVIDE civilian-defense volunteers with a cheap and easy-to-build airplane detector, Dr. Donald A. Wilbur and Rodney F. Simons of the Department of Physics of Rensselaer Polytechnic Institute, Troy, N. Y., designed and constructed this unit from materials readily available to any radio repairman or amateur for less than $50. R.P.I. sends the complete plans and instructions to authorized civilian defense units requesting them.

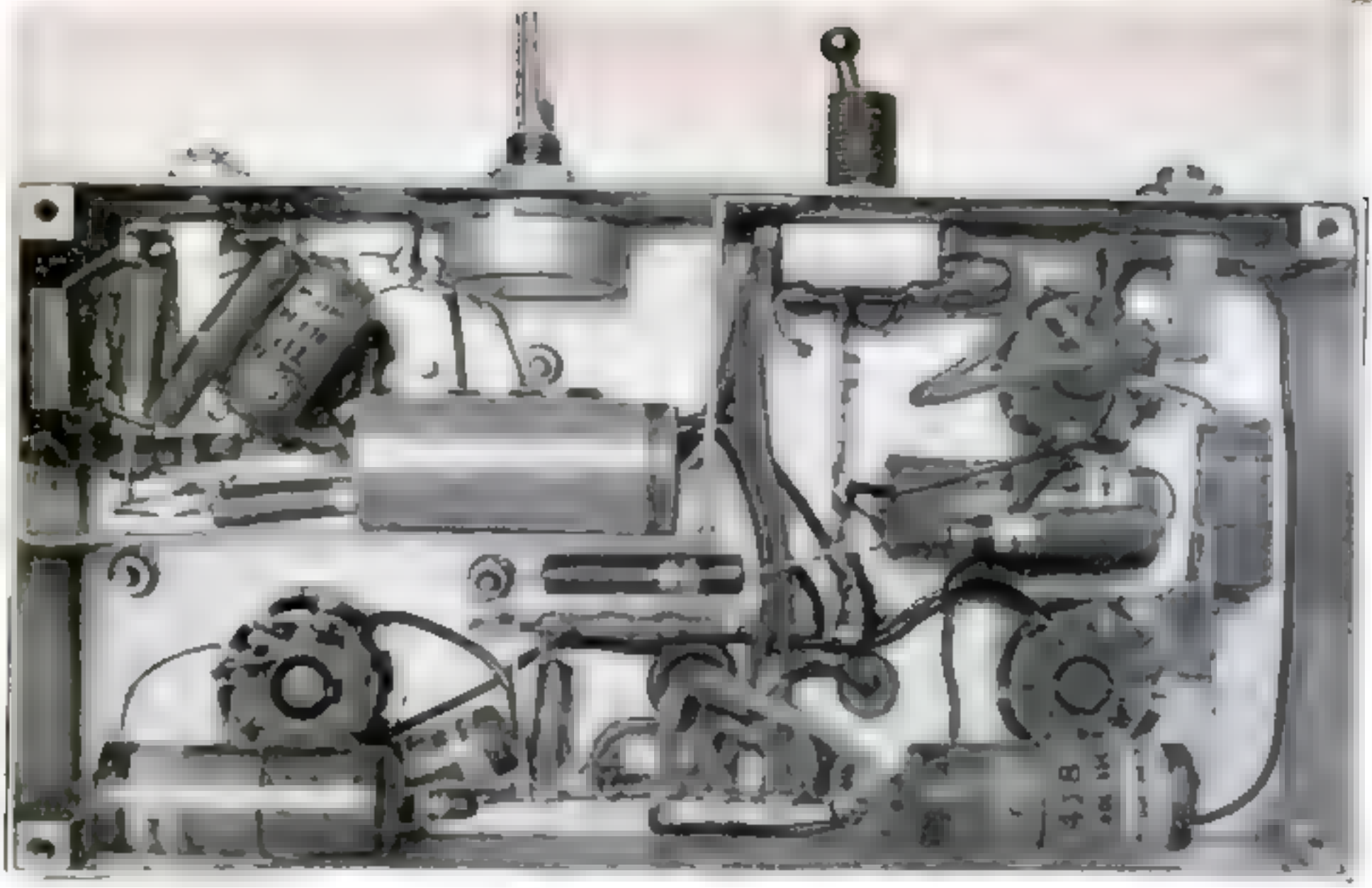
"Aircraft spotters" working with powerful field glasses on clear days would sight enemy bombers in plenty of time to sound air-raid alarms. At night, however, or when visibility is poor, the only sure method of detection is by sensitive listening devices.

A small edition of the three-horn bomber locator pictured on the cover of the December issue of P.S.M., the homemade plane detector is sensitive enough to pick up a normal conversation three blocks away! This would allow listeners to spot raiding planes at a distance of five to ten miles.

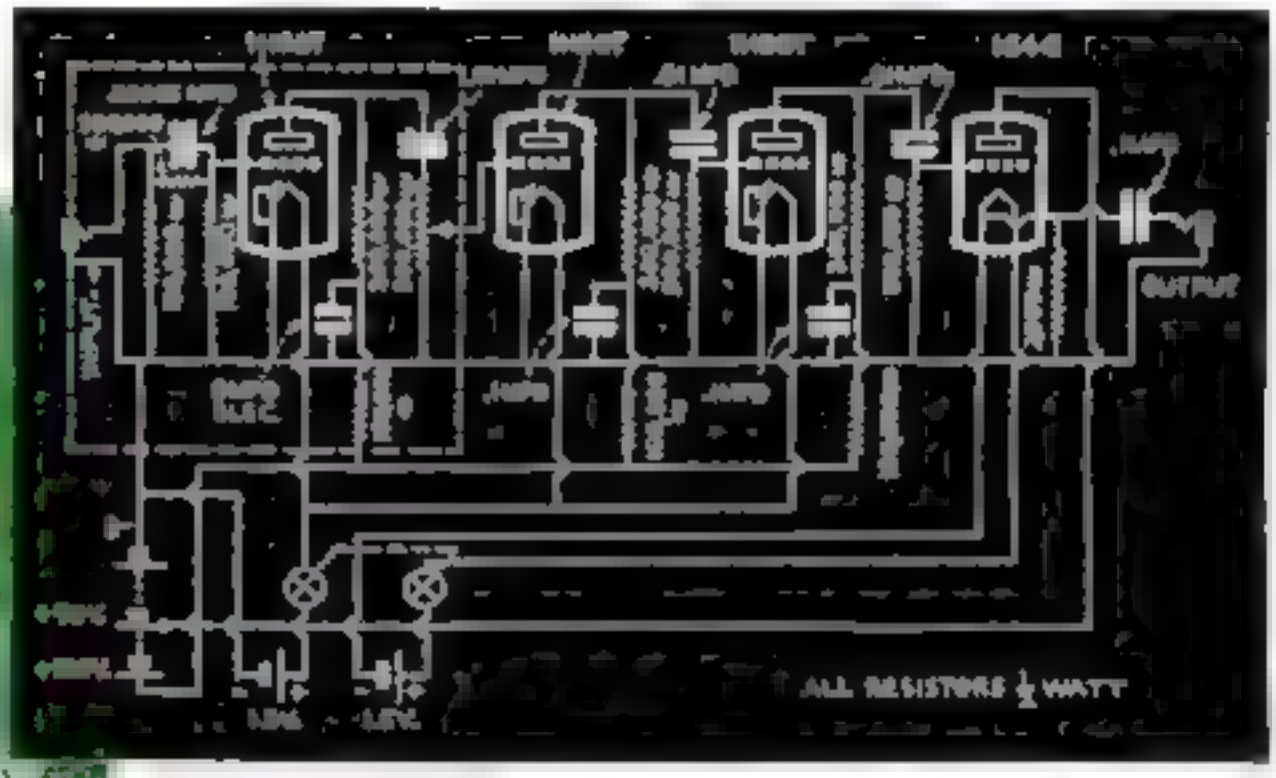
The listening "ear" is made



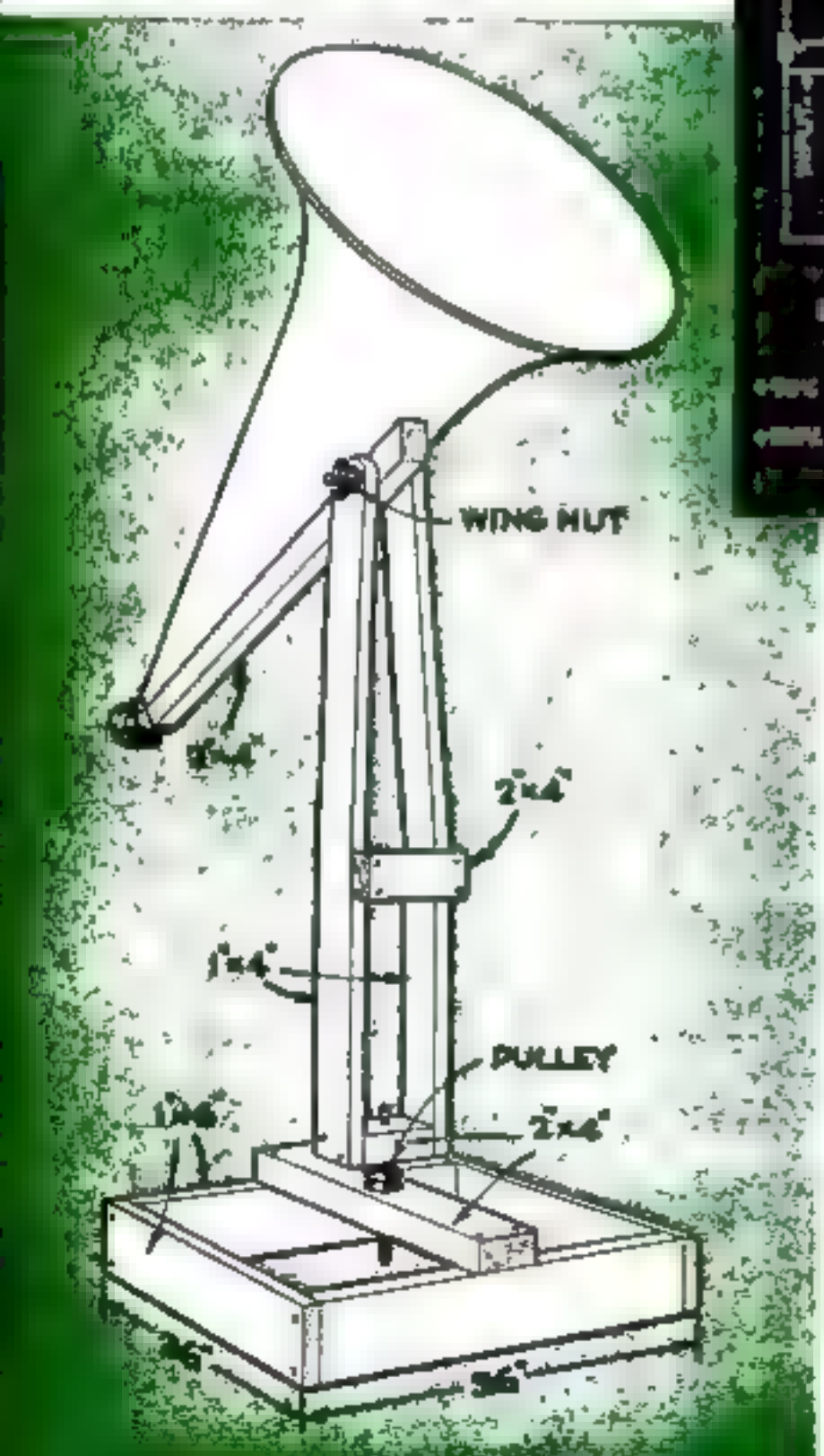
Aircraft listening device set up on a hill to detect approaching planes. At left is the carrying case containing amplifier and batteries. Below, the microphone installation. (Note A rock-wool plug suppresses resonance)



Underside of amplifier chassis. First stage is shielded to prevent feed-back. Earphones are plugged into output by a jack



Wiring diagram of the amplifier circuit. The drawing at left gives construction details for the standard. The mouth of the horn should be covered with a single thickness of light cloth



from the horn of an old-fashioned phonograph, with a crystal or other type microphone in the small end. If this kind of horn is not available, a satisfactory substitute could probably be made from sheet metal. It is mounted on a swivel base and can be adjusted to any angle. The supporting stand is easily built from scrap lumber.

The faint impulses received by the "mike" are carried through shielded cable to a portable four-stage resistance-coupled amplifier, the first stage of which is completely shielded to prevent feed-back. All power comes from batteries, making the device independent of line failures. Earphones are connected to the output.

POPULAR SCIENCE

Home Workshops Pitch In for War Work

WHAT YOU CAN DO FOR VICTORY

THE WAR PRODUCTION BOARD TAKES STEPS TO SPEED USE OF SMALL SHOPS . . . SOME CRAFTSMEN ALREADY AT WORK GIVE AMAZING DEMONSTRATIONS OF SKILL AND INGENUITY . . . POPULAR SCIENCE CONTINUES ITS SURVEY WITH THE REGISTRATION FORM ON PAGE 79

By ARTHUR GRAHAME

BY REGISTERING their skills and their machine tools in the national survey of home-workshop facilities being made by POPULAR SCIENCE MONTHLY, many thousands of hobbyists and professional craftsmen have volunteered to fight in the vitally important battle of war production being fought *now* by American industry.

This stock-taking of an untapped and until now unmeasured reserve of emergency manufacturing power has not yet been completed. Large numbers of registration forms continue to come in from all over the country. There still is time for you to show your willingness to do your part in what, fundamentally, will be the decisive battle of the war. If you own a machine tool, know how to use it, and can devote either all your time or your spare hours to helping to produce the weapons that our fighting men must have to win, fill in the registration form on page 79 and mail it today.

Speed is a vital necessity in every detail of our stupendous war-production drive, and the Contract Distribution Branch of the War Production Board is not waiting for the completion of the survey to make every practicable effort to put to work the craftsmen who have registered.

A new development that promises to help

HERE'S AN EARLY HOME FACTORY

ONE of the first craftsmen to turn his home into a factory is Homer C. Price, of Columbus, Ohio. He subcontracts for a Cleveland firm.

In one room he has a drill press, bench lathe, three-ton punch press, small precision vertical milling machine, universal grinder, and internal grinder; in the kitchen, a lathe and two tool grinders; in his garage and dugout, two large drill presses, one large vertical milling machine, a power hack saw, and a large horizontal milling machine. In other rooms are three more lathes.

Everything to date has been in his home, but he has now broken ground for a small factory building on a lot next to his house so Mrs. Price, who knows how to operate most of his machines, can have her kitchen back.

greatly in bringing the small shops into production is the recent action of Donald M. Nelson, head of the WPB, in directing that contracts are to be placed by negotiation instead of competitive bidding. Primary emphasis is to be put on speed, not cost. Contracts for standard and semi-standard articles that are relatively simple to make are to go to smaller concerns, so that the larger and better-equipped factories may be used for the more complicated, difficult jobs. This opens the way for contractors and subcontractors, now freed from having to figure on a strictly competitive basis, to let out more work to small shops and home workshops, cost what it may. The purpose is to spread the work and get it done more quickly. Speed is the first consideration.

In some respects, however, speed will have to be made slowly. The craftsmen who have offered their services by registering are eager to get to work, but many of them will have to do some patient waiting, which is the hardest thing in the world to do these days. What was said last month in that connection must be said again: After you have done your part by registering, try to be patient. Wait until your services are called for. Don't visit or telephone or even write letters to your local WPB office—doing that will only delay the work of organization.

Machine-shop students at the Milwaukee, Wis., Trade and Technical High School, under the instruction of F. H. Schoenig . . .

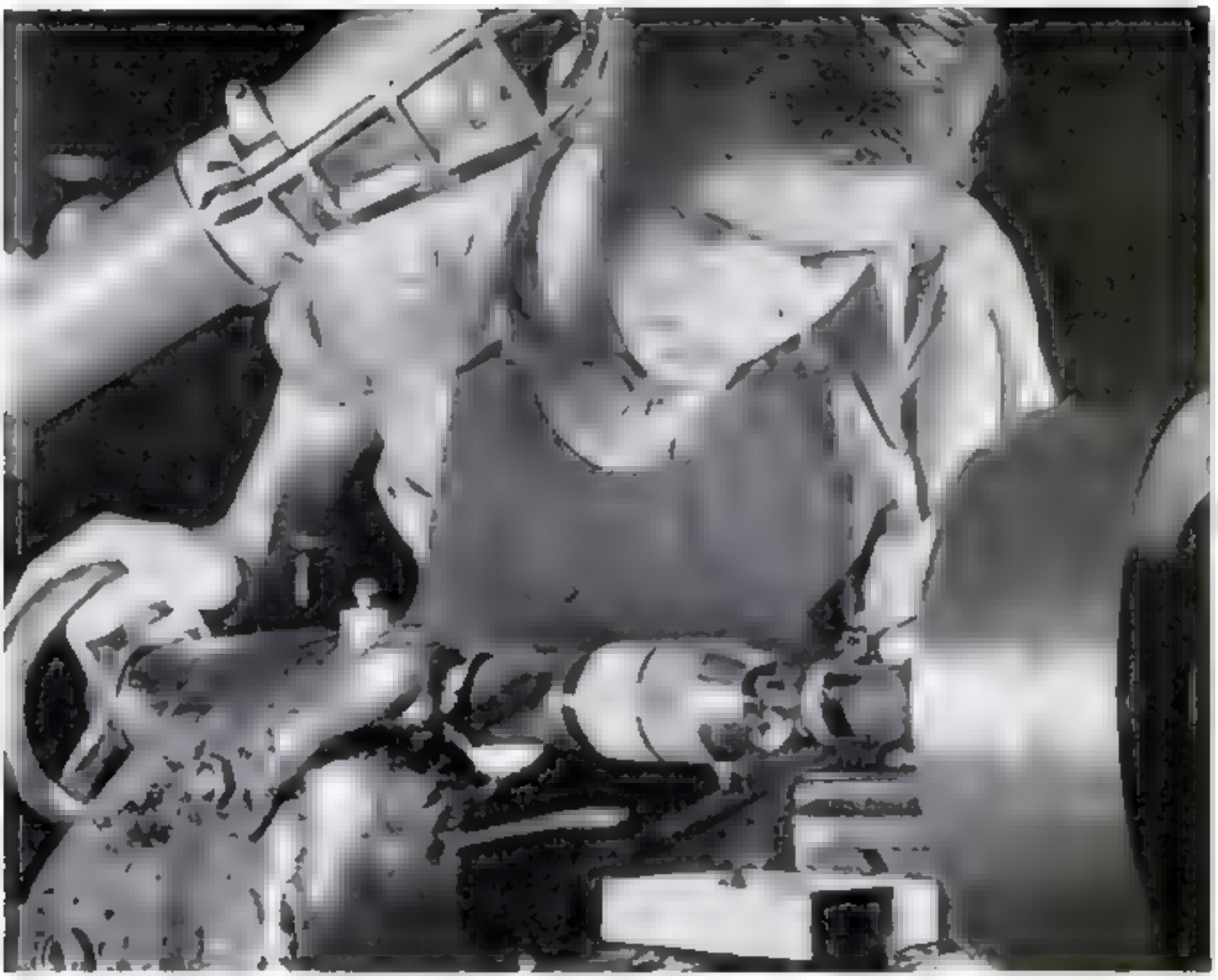
If your registration form shows that you have the necessary skill and tool equipment, soon or late your turn will come. Every competent craftsman and every serviceable machine tool in the country is going to be needed to finish the biggest production job that ever has been undertaken by any nation.

As the details of manufacturing facilities now are military secrets, we won't be able to publish the over-all results of the home-workshop survey, but study of the registration forms as they come in shows that a very large proportion of the registrants have both the mechanical skill and the machine-tool equipment necessary to make them highly valuable in war-production work.

The number of high-class power tools owned by the operators of very small machine shops and by hobbyist-craftsmen has astonished production engineers. A tabulation of 1,000 registration forms shows a total of 3,058 metal-working tools—among them 948 lathes, 682 drill presses, 371 grinders, 111 screw machines, and 184 sets of welding equipment — and 1,308 power woodworking tools. Although a high proportion of this particular thousand registrants want to do their war work in their spare time, well over half of them are men with professional mechanical experience—toolmakers, machinists, welders, mechanics, engineers, and draftsmen. The others are men—and one woman—in nonmechanical occupations who have made work with machine tools a hobby

Among those who have registered is a New York advertising man who studied engineering in college and who learned to operate various machine tools in his father's factory. During the past ten years he has devoted much of his leisure to making navigation instruments and camera fittings in his home workshop. He is accustomed to working to .0005" tolerances, and can give 30 hours a week to war work.

A Montana man whose regular job is the supervision of grain inspectors has a well-equipped basement workshop; he also can give 30 hours a week to war production.



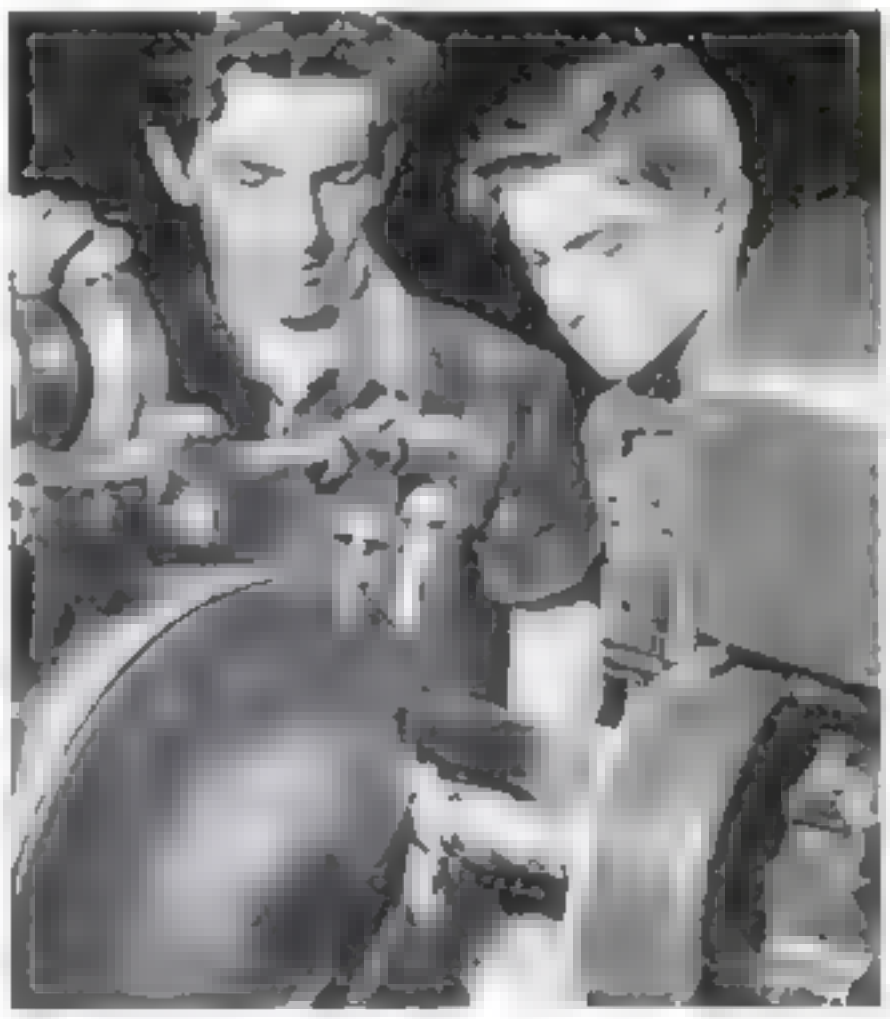
. . . are making feed shafts for milling machines. Walter Holtz, one of the boys, is seen above centering a steel bar in a lathe. The students get no wages, but work for the experience—and to help beat Hitler

A Tulsa, Okla., salesman has been a home-workshop hobbyist for 11 years, and is willing to work 54 extra hours a week to help lick Hitler. A San Pedro, Calif., stevedore, wants to devote the skill he has developed in building model race cars and gasoline-engine-powered model planes to helping win the war.

Many owners of small machine shops have registered. One of them, a New York man, has been making experimental metal airplane models for 20 years, and also has had experience on airplane parts and boat and torpedo fittings. Priorities have made his well-equipped shop idle, and he wants to shift to full-time war production. A Missouri man who is head of a small firm making equipment for printing on sheet metal wants to convert his plant to almost any kind of war work. An upstate New Yorker wants to get into war production and work his eight-lathe shop 168 hours a week on it.

Several years ago the German government began to sell farmers small electric motors to drive milking machines, feed grinders, and other labor-saving gadgets. In 1937 the farmers who had bought motors

Below, looking over a lathe. Only advanced students are taking part in the defense work, which calls for a high degree of accuracy in some parts



received sealed boxes, with orders that they should be stored unopened. Officials who appeared shortly after the boxes arrived said that they contained machines for making toys and similar products, and that before long a government instructor would come around and show the farmer how to operate the machine and make some extra money. Nothing more happened until the German army stormed into Poland. Then the government instructors appeared and ordered that the sealed boxes be opened. Instead of toy-making machines, they contained power tools such as small drill or punch presses, automatic screw machines, and drop forges. The instructors taught the farmers how to use these machines for operations such as making airplane rivets, rough-drilling holes in connecting rods, and punching rivet holes in tank armor. When the farmers had attained a satisfactory degree of skill, they were given a supply of material and told to start producing—*entweder oder*. That was the beginning of a bits-and-pieces program which has brought every machine tool in Germany and every out-of-the-army German who can use one into the Nazis' tremendous war-production drive.

Worried by the threat of Germany's rapidly growing *Luftwaffe*, the British started expanding their aircraft industry in 1935. New factories were built and new workers trained, but in 1938 the new factories hadn't produced a single airplane. Then the government forced the aircraft manufacturers to subcontract 35 percent of their work to firms outside the industry. Within a year Vickers Aircraft had 700 large and small subcontractors, Rolls Royce was farming out work to several hundred small machine shops all over the country, and the subcontractors had hired more new workers than the aircraft industry had recruited in the preceding five years. That was how the British bits-and-pieces system started.

After France cracked, the program was expanded tremendously. Regional boards were organized to list every machine tool in Great Britain and see to it that every one of them was kept hard at work. Surveys showed that an astonishingly large proportion of even the smallest machine shops were capable of high-precision work. An American machinist who spent many years in England says that the interest of the British working man in model building has made accuracy and fine craftsmanship a national hobby. Even the smallest shop is given all the work it can do; it isn't uncommon for four or five of them to work on a single part, such as a dolly wheel of a tank.

Down-to-the-smallest-shop subcontracting is being used to mobilize the last ounce of Canada's war-production effort. It has increased production, just as it has in Great Britain and in Germany. One large firm built a plant designed to produce eight 25-pounder field guns a month. That plant now is turning out 50 of those guns a month. The increase in production was made possible by bits-and-pieces subcontracting. Almost half of the 1,286 parts which go into the building of a 25-pounder are being made in 63 small plants scattered over Quebec and Ontario. The smallest of them is a two-car garage operated by its owner and two helpers.

The survey being made by POPULAR SCIENCE already has proved that in our very small machine shops and in our many thousands of home workshops we have a vitally important reserve of efficient machine tools and highly skilled craftsmen.

And by doubling and redoubling the production of his Passaic, N. J., plant through sub-subcontracting to hobbyist craftsmen who do his work with their own tools and mostly in their spare time, Stanley A. Carlson—*now* a WPB industrial consultant—proved that this reserve can be made of tremendous value to America in the most dangerous hour of its history.

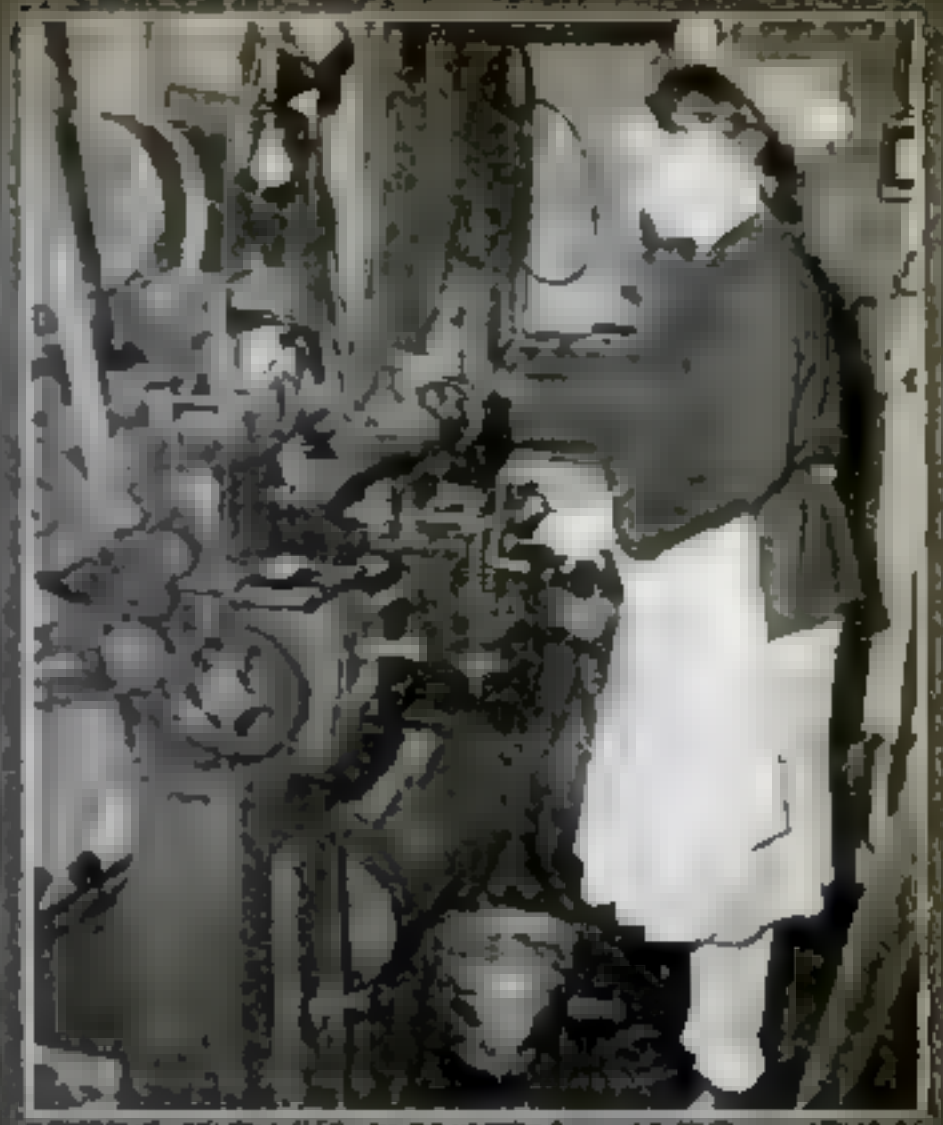
In other parts of the country patriotic and energetic craftsmen have proved the same thing. For example, the LaRoe family, of Eustis, Fla., which has four generations working on a subcontract for gears and worms obtained from an aircraft manufacturer.

Fifty-two-year-old Earl LaRoe went to Florida from Ohio 30 years ago and bought an orange grove. He set up a small shop in a garage on his property, and increased his income by repairing orange-grove equipment for his neighbors. When the war started, LaRoe had more right than most men to feel that he already had done his part—he has three sons in the Army, one of them in the Philippines. But he wanted to do more, so he went after and obtained a subcontract.

To do the work he had contracted for, he needed additional power tools. He found plenty of them stored away in garages and warehouses, and even on junk piles. He bought those he needed, and he and his son Clarence put them into working order. They converted one old lathe for high-speed work by using the transmission of a junked car, and another by using parts from an old washing machine. Five weeks after they started retooling, they were ready to start work on their subcontract.

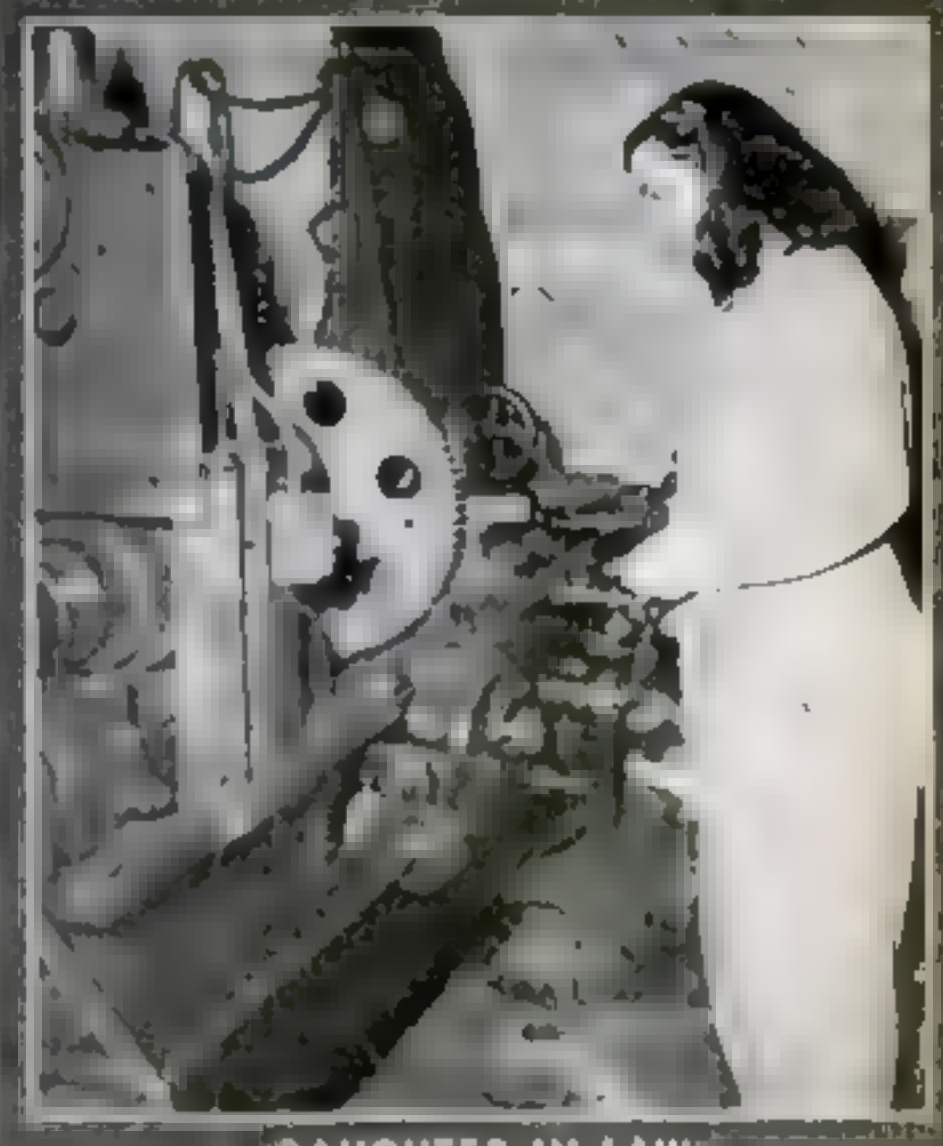
LaRoe and Clarence worked 18 hours a day, but found that they couldn't keep up with their production schedule. LaRoe's sister, Ruby Laurence, was visiting him. He gave her a suit of dungarees and put her to work watching a lathe. She's a grand-

FATHER



MOTHER

SON



DAUGHTER-IN-LAW

THIS GARAGE WAR WORKSHOP IN FLORIDA IS STRICTLY A FAMILY AFFAIR

Native Americans ingeniously have transformed a Florida family tomato machine of war production, with four generations working to turn out machine parts for defense. Chief Lukas is the head of this little factory on a 40-acre orange grove near Eustis. Until two months ago, he used his 30 by 30-foot garage for repairing [illegible] equipment, then fashioned up with [illegible] machines and got to [illegible] to make war [illegible] gears for defense. His helpers [illegible] his brother, his wife, [illegible] daughter-in-law, and a grandson [illegible] when [illegible] short shortage in the [illegible]

mother, but she likes the job, and has gained weight.

Still LaRoe didn't have enough "manpower" to keep up with his stiff schedule. So Clarence's attractive 24-year-old wife was drafted. After a few days she was joined by Mrs. LaRoe. That solved the labor problem, but it didn't leave anyone with enough time to do the housekeeping. This was 75-year-old "Granny" LaRoe's chance to do her bit. She cooks the meals, washes the overalls, takes care of the children, and makes the beds. Earl Eugene LaRoe, her five-year-old great-grandson makes himself useful by carrying to the scrap pile the steel shavings turned off by the lathes.

In Milwaukee, 15 advanced students of the Boys' Trade and Technical High School are keeping very busy on a contract for 600 reverse bevel-gear and primary feed shafts awarded the school by a Milwaukee firm of milling-machine builders, which holds a number of defense contracts. The boys are working for Uncle Sam—working to turn out some of the tools which the Government needs to arm its fighting men—and they are working with the zest that pours forth when youth is given responsibility and a mission to perform.

The job demands really expert workmanship, as the allowable tolerance in some dimensions is only .0005". The work is done only during regular school hours, and under the supervision of the usual teachers. The school will be paid the standard rate for the work, but the students will get nothing but experience and satisfaction.

The project is an experiment, and the Milwaukee school is the first in the country to combine instruction and actual production for the war effort. The boys are, however, doing a surprisingly fine job, according to their instructor, Fred H. Schoenig, who conceived the idea of bringing defense work into the classroom several months ago and who is highly enthusiastic about results.

No one who has had anything to do with war production subcontracting is foolish enough to think that it is an easy road to victory. It is a system which produces more than its share of headaches. To get satisfactory results, prime contractors must give their subcontractors generous technical help. Because small shops usually can't do work as cheaply as large shops, subcontracting costs often run high. But in the existing crisis, speed is much more important than money. The reserve of machine tools and skilled craftsmen uncovered by the POPULAR SCIENCE survey therefore promises to become a valuable factor in the production drive to turn out war supplies and weapons.

U. S. Wants ALL Home-Workshop Owners to Register for War Production

IT is urgently necessary to find out at once what contribution the home workshops of the United States can make in the production of war materials.

To obtain this information with the least possible delay, POPULAR SCIENCE MONTHLY is making a survey to be placed at the disposal of the War Production Board in Washington. The individual forms, after being numbered and recorded, are sent to Washington for study and redistribution to the field offices of the Contract Distribution Branch of the Production Division, WPB.

The purpose of the registration is to provide a comprehensive survey of immediately available home-workshop facilities—manpower, skills, and equipment. What we are asking you to do now—and all we are asking you to do—is to say that you will devote your skill, your shop equipment, and your spare time or full time to this work if and when the Government asks you to do so.

It should be made clear that this work is not to be contributed without pay. Usually it is done for contractors, not directly for the Government. Because of this, home-workshop operators are freed of all red tape involved in so-called "direct procurement." They are supplied with materials, so they do not have the difficulty of obtaining their own. They are also given various production aids and bookkeeping assistance.

Please bear in mind that even the task of surveying available home workshops is a gigantic one. Because the task is so immense and because every one concerned is straining to increase production as quickly as possible, we ask that those readers who fill out the form do not become impatient. Above all, DO NOT WRITE, PHONE, OR VISIT the district offices to inquire about registrations. It will simply impede matters and cause confusion and delay.

The thing for you to do—and do now—is to register. To win the war, men and machines must be mobilized in one great, all-out effort. Do your part by filling out the survey form today.

WAR-WORK REGISTRATION FORM FOR HOME CRAFTSMEN

Note: DO NOT fill out this form if you have previously registered. Instead, call it to the attention of some friend or neighbor who might be interested in registering. If you wish to avoid cutting these pages, you may obtain a duplicate of this form by sending a self-addressed, stamped envelope to Popular Science Monthly.

S 5

NAME_____

(Please print or typewrite)

STREET ADDRESS_____

CITY OR TOWN_____

COUNTY_____ STATE_____

Age_____ Occupation_____ Position held_____

Are you regularly employed, employed part time, unemployed, or a student?_____

Check the schools from which you have been graduated.

☐ Grade school ☐ High school ☐ Vocational school

☐ Correspondence school (_____ course)

☐ College (major subject, _____)

What mechanical experience have you had?_____

Check which of these machines (or equipment) you can operate, and add any not listed.

	Grade		Grade
☐ Metal-turning lathe	_____	☐ Metal shaper	_____
☐ Drill press	_____	☐ Screw machine	_____
☐ Milling machine	_____	☐ Boring machine	_____
☐ Welding (arc, spot, torch)	_____	☐ Heat-treating	_____
☐ Grinding (surface, etc.)	_____	☐ _____	_____
☐ _____	_____	☐ _____	_____

Note: After each machine or type of equipment you have checked, please add one of the following letters to indicate the degree of skill you possess: E for expert or foreman grade, J for journeyman or average grade, S for semi-skilled or apprentice grade, B for beginner.

Can you read simple blueprints?_____

What mechanical projects, articles, or parts have you constructed, either for pay or as a hobby?

If you operate a metal-turning lathe or other machine-shop tool, what is the minimum tolerance to which you are accustomed to work?_____

FORM CONTINUES ON NEXT PAGE ⟶

LIST THE MACHINES IN YOUR SHOP AVAILABLE FOR PRODUCTIVE WORK

MACHINE	SIZE, TYPE, AND MAKE	CONDITION

In case you are called upon to make parts or do special work for a Government contractor or subcontractor, how many hours a week could you devote to this activity, provided the materials were supplied and you were paid at a reasonable rate?

Are you able to give instruction in machine-shop practice to others? How many hours a week could you teach? Could your own machines and equipment be used for such instruction?

If you are familiar with any part or assembly of war matériel which you would be especially interested in making, please describe it as completely as possible

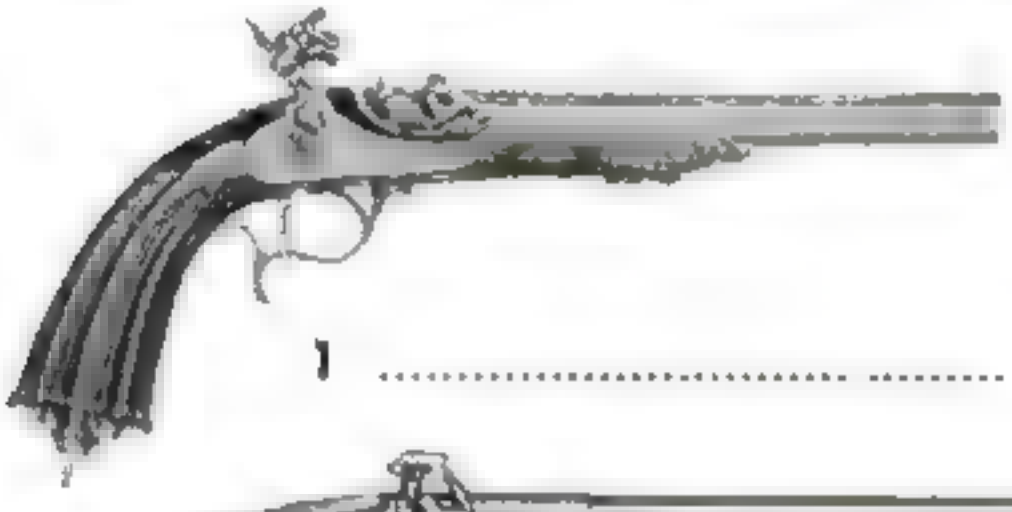
List the names and addresses of other mechanically minded men who might be interested in enrolling for this type of work so that registration forms may be mailed to them.

IT IS URGENT THAT THIS SURVEY BE COMPLETED AS QUICKLY AS POSSIBLE. PLEASE FILL OUT THE FORM IMMEDIATELY IF YOU ARE ABLE TO HELP PRODUCTION IN ANY OF THE WAYS MENTIONED. ADDRESS WAR-WORK REGISTRATION, POPULAR SCIENCE MONTHLY, 353 FOURTH AVENUE, NEW YORK, AND MAIL AT ONCE.

THIS IS IMPORTANT ***TIME IS SHORT*** ***ACT AT ONCE—TODAY***

Question Bee

WHAT do you know about pistols? Thousands of inventors have contributed to changes and improvements since the first pistol appeared about 1530. Attempts to increase firing capacity have led to every conceivable form, sometimes to multiple barrels, types of firing mechanism have developed from wheel lock through flintlock to percussion. Can you identify the nine pictured below, giving their style, country, and approximate date? Write your answers in the spaces, and check below.



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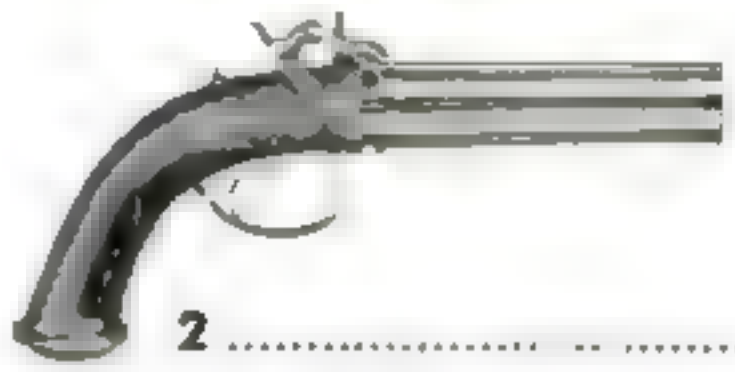

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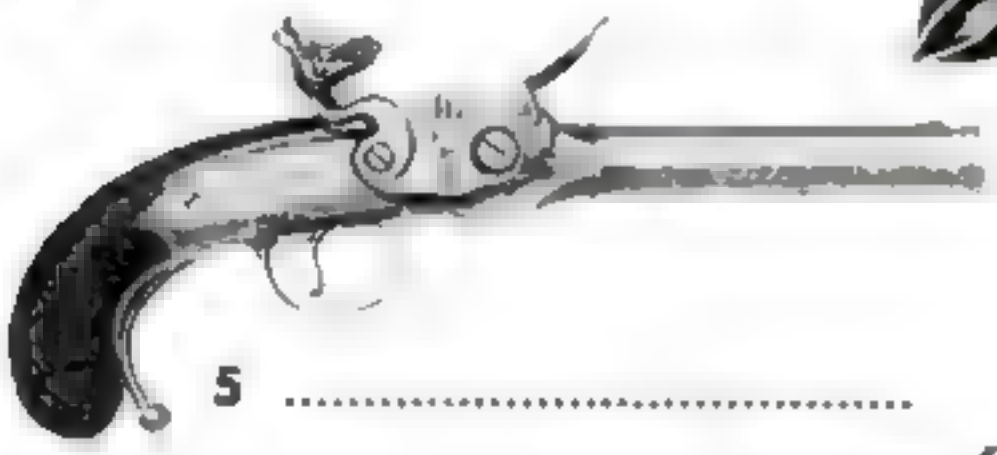


5 .....

6 .....

7 .....

8 .....

9 .....

ANSWERS

1 Percussion pistol (French, 1850).
2 Four-barrel percussion (English 1830).
3 Wheel-lock (Dutch, late 17th century).
4 Double-barrel wheel-lock (Dutch or Flemish, 1612)
5 "Repeating" flintlock (English, 1800) Balls were stored in the stock
6 Colt official police revolver (U. S., modern)
7 Colt Army percussion revolver with stock (U. S., 1860).
8 Colt Navy percussion revolver (U S., 1851).
9 Colt automatic pistol (U S. modern).

SPEEDY, HARD-HITTING BOMBERS FORM THE Porcupine

Using the A-20 Attack Bomber, Famous Abroad as the Boston and Havoc, U. S. Army Airmen Develop New Tactics to Blast Enemy Troops and Supply Lines

• • •

YOU may talk all you want about your heavy bomber, which comes in from almost incredible distances and unpacks its punches from invisible altitudes. Nobody but its own crew is ever going to love it. Nobody ever loves the fighter with a bicycle, who dances around the corners of the ring and lets loose his blows by remote control

This story is about a lightweight. It hasn't been ballyhooed nearly as much as the big boy, but it's the fastest, toughest, bloodthirstiest infighter on wings.

Squadron

By HICKMAN POWELL

With its shoulders hunched forward in a Jack Dempsey crouch, it sails right in and mixes it up on the enemy's own ground, with kidney jabs and rabbit punches. When the American soldier comes personally to grips with the enemy, this plane will be right in there with him, bombing from 75 feet above ground, biting in the clinches. The American soldier is going to love it, as an intimate comrade in arms. The British love it already, for the enemies it has slaughtered.

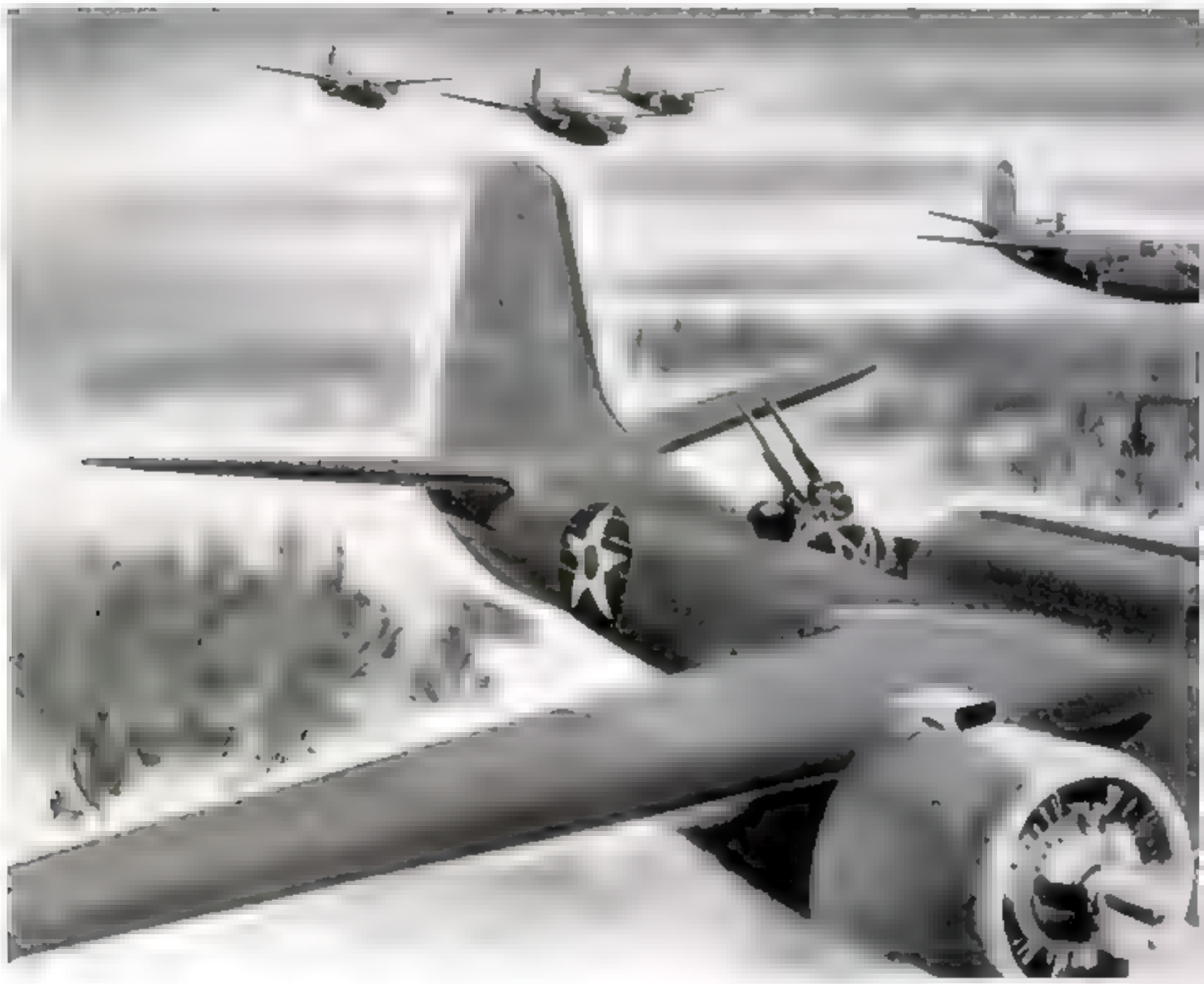
In its already long record of homicidal wickedness, this ship has four aliases. Americans know it as the DB-7 and the A-20A. The British call it the Boston and the Havoc. It has as many specialties as it has names, but whatever may be the job, it always has the same fingerprints and sharklike killer's mug. It is the Douglas light bomber.

Designed as a bomber, weighing 9½ tons loaded, this twin-engined plane attained its first great usefulness as a fighter, and a night fighter at that. It first reached England at a time when the British were concerned, not with the ground-strafing of troops, but with the interception of the night bombers which were destroying London. The Night Interceptor Command took the ship, blacked out its goldfish-bowl nose where the bombardier sat, and filled the space with the greatest arsenal of cannon and machine guns ever put into a fighting plane. They shrouded the ship's exhausts with long tail pipes to hide the spitting flames and fitted it with secret devices for scenting enemies at night. They cut a ton off its loaded weight. They called this modification the Havoc.

Soon it was knocking down night bombers as they came in over the Channel, getting the reputation for destroying more of them than any other interceptor. Then a still more aggressive job was devised for it, described as "night intrusion." The Havoc slips over to the Continent, using its 1,200-mile range, and lurks near a Nazi airdrome like a weasel around a hen coop, picking off the bombers as they start out for England or come home to roost.

To the American builders, this metamorphosis of the DB-7 was a surprise and a delight. The manufacturers put it into mass production, hopped up its power. It was

drawing show demolition area; because, the parachutes are necessary to delay explosions until the bombers are out of range of blast



one of the very first ships to get double-row engines. The British aeronautical press, never inclined to overpraise American planes, was permitted to report that Havoc III, the latest version, had a top speed of 380 miles an hour. This would make this relatively heavy ship faster than the Hurricane, right in the Spitfire class.

Meanwhile the American, light-bomber, version of the ship was christened the Boston by the R.A.F. and was found useful not only for attack work by daylight but also for the highly important jobs of observation and reconnaissance.

Naturally the success of their flying protégé in the night life of the Continent tended to cramp the style of the light-bombardment men in the U. S. Air Forces. They couldn't get as many ships as they wanted, but they had enough of the A-20 to try it out thoroughly in their own tactics, a technique of attack which they had been developing for the last 20 years. This is a type of low-down assault so utterly different from the uses of the Havoc that it is amazing for one ship to be useful for both purposes. But the A-20 turned out to be an ideal ship for contour flying, which the pilots themselves call grass-cutting or skipping through the dew

Let's take a look at the A-20. It is a shoulder-wing monoplane, with its two radial engines in two big underslung nacelles, which taper back far beyond the trailing edge of the wings. The big wheels of the tricycle landing gear retract into these nacelles. The narrow fuselage projects forward into a nose almost as long as the tail which leads back to an unusually high fin. The pilot's single cockpit is forward of the propellers and the bombardier's transparent compartment occupies the nose. The gunner (or gunner and observer) can work both from a rear cockpit and from an opening in the plane's belly. The ship has a span of 61 feet 4 inches and is 47 feet 7 inches long. Loaded it weighs 19,500 pounds.

Even sitting on the ground, the plane has a sporty, aggressive look, as though its shoulders were hunched forward ready for a fight. Studying this, you realize that its

They call the A-20's the porcupines because in action they hug the ground, speeding just a dozen feet above the tree tops, their backs bristling with two 50 caliber machine guns each to guard the only possible approach open to an attacking enemy fighter plane—a suicidal dive from above

wings are tilted, not up, but downward. They have what the aeronautical engineers call a negative angle of attack. Speeding down the runway on the take-off, the plane has no immediate impulse to fly, but rather presses its nose down, taking up all the slack in the shock absorber on the forward wheel of the landing gear. To start it flying, the pilot has to pull back on the stick, pushing the tail down. To cut down wind resistance and increase speed, this ship takes advantage of a remarkable fact of aerodynamics: that a wing with unsymmetrical camber (bulging on top and flat on the bottom) can lift without being turned up into the wind, can lift even when it is cocked down. This peculiarity makes necessary a very high landing speed. The A-20 is a hot ship.

But the exciting thing about this ship is the way it is used, by the American light bombers as well as by the British night fighters. The A in its name stands for "attack," and the flyers who use it were known officially until two years ago as attack squadrons. Their tactics, on which these squadrons have been working for the last 20 years, are to fly in upon an objective at such low altitude that they practically skim the treetops. By using parachute bombs which give them an instant for escape, they can blast troops from an altitude of only 75 feet and be safely out of the way before the explosions. Otherwise, they would be felled by their own bombs.

The A-20A flyers of the 3rd Bombardment Group (Light) pride themselves that, following the contours of the land at 75 feet altitude, they can go to an objective 300 miles away and bomb it within a half minute of a specified time. Plenty of flyers in this outfit have nicked the tops out of pine trees in the course of their training. During the Louisiana maneuvers an A-20 pilot sheared his plane through a cluster of five high-tension wires, without damage to anything but the power line.

The surprise and terror of an approach by a flight of these planes, flying more than 300 miles an hour so close that you can almost touch them, is something which must be seen and heard to be appreciated. When I first saw them, a flight of eight A-20's, followed by Navy Grummans and P-39 pursuit ships, came in suddenly and low over an air field in North Carolina. There were 12 press photographers there, but so fast and furiously did those planes arrive and depart that not a photographer got a shot at them. It would have been even more difficult to catch them with a machine gun.

Imagine a road through the jungle, streaming with Japanese troops. Suddenly there is a roar of approaching planes, but before the direction of approach can be identified, the planes appear over the treetops only a few hundred yards away, traveling 160 yards a second. There are three of them, one for the center, one for each side of the road. Before a machine gun can be aimed, they are over and past, each dropping a bomb every ten yards for 1,000 yards. By the time this article gets into print, it may not be necessary to imagine this scene of destruction. It may very well have happened.

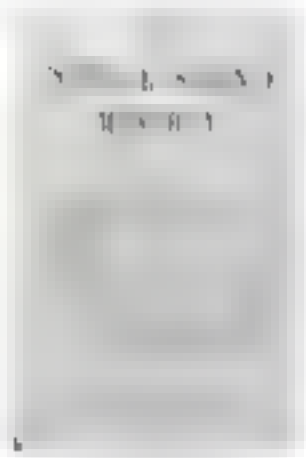
Recently I flew on a mission with one of these squadrons. Out of consideration for local residents they were flying at an altitude of 500 feet or above, but over a stretch of uninhabited country they came down

The pilot steps into his single cockpit from one of the high wings. Note the underslung engine nacelle. Although it is well back in the long fuselage, the cockpit is still set forward of the two propellers

Up in the transparent "goldfish bowl" at the nose of the ship sits the bombardier, an important member of the A-20's crew

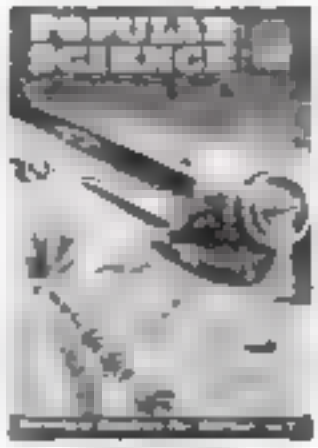
He enters his compartment by a trapdoor just ahead of the forward landing wheel

OUR COVER—THEN AND NOW



1872

THE contrast between the early cover of POPULAR SCIENCE MONTHLY reproduced at the left, and the painting by Jo Kotula on the present issue, is symbolic of the changes that have occurred in the 70 years since this magazine began reporting the progress of science and industry. Then, the telephone, the electric light, the automobile, and the airplane were unknown. Herbert Spencer, English philosopher, was one of the contributors to the old issue shown here.

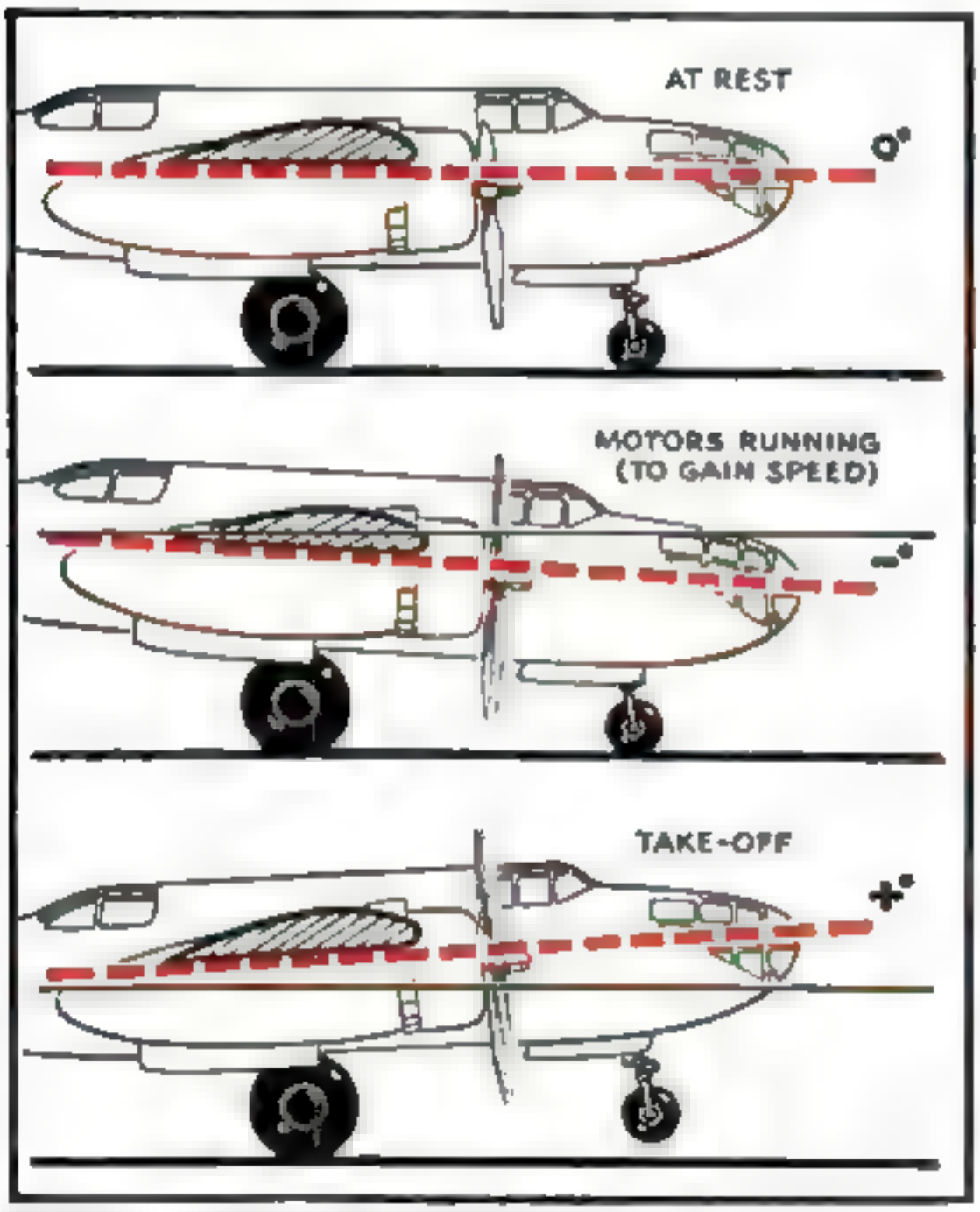


1942

close over the treetops and showed me what hedge-hopping is really like. Sitting up in the transparent nose of the lead plane, traveling better than 300 miles an hour, over treetops which often were no more than 20 feet below, following the hills up and down like a skier—it was an experience which can only be stated, not adequately described.

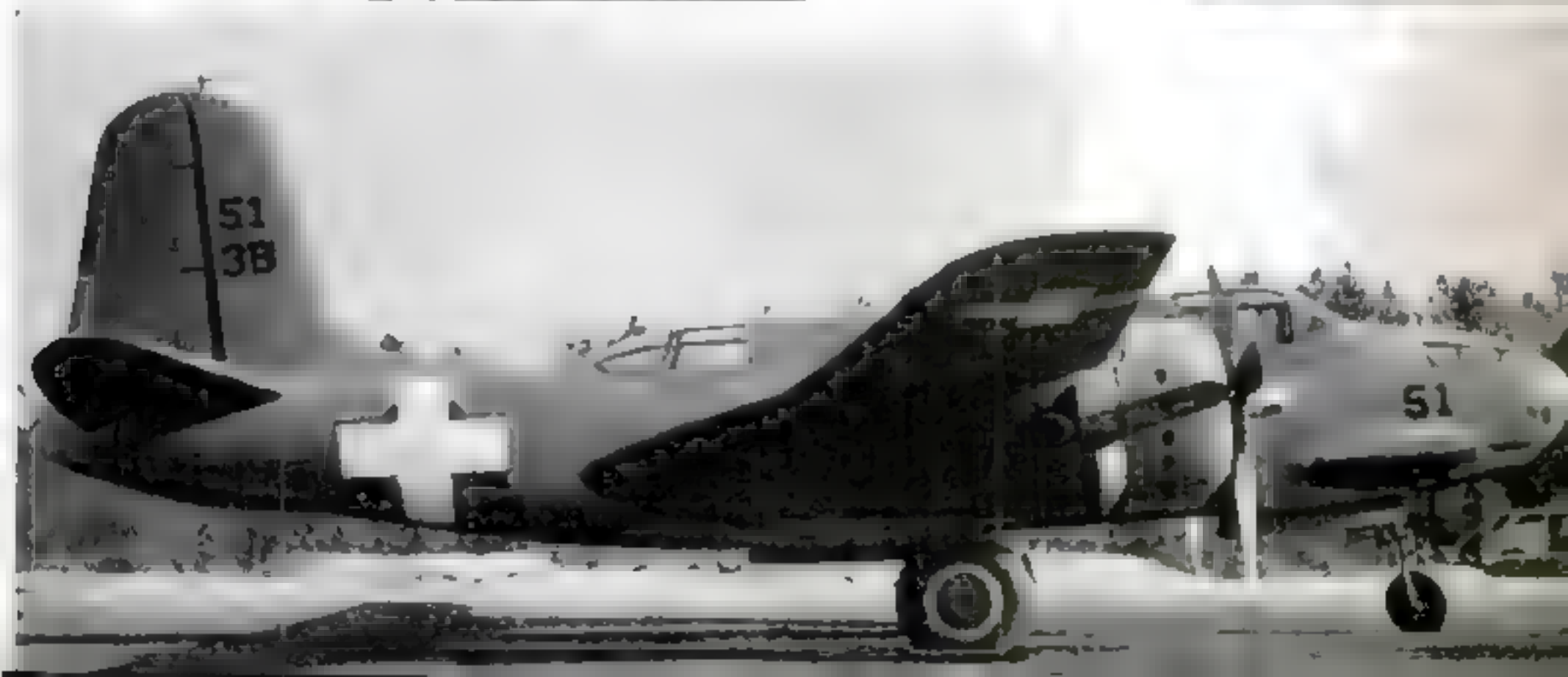
Flying as a squadron this way, we were almost proof against attack. Ground observers more than a few hundred yards away could not see us. Often we were down in a ravine with ridges of land rising on either side. Pursuit planes could not get at us. The A-20 has a critical altitude of 1,000 feet above sea level; that is, its engines perform best when right down by the ground. Most pursuit planes are built to fly above the clouds, and they will burn their engines out if they fly at wide-open throttle close to the ground. To get at us, at our speed, fighter ships would have to dive. And when a fighter ship pulls out of a power dive, it mushes or squashes through the air for a long distance before its wings finally support it. A plane diving at us would have a very good chance of crashing into the ground. Assuming that fighter ships did get down close to our level, they could not get under us. And if they came in over us they would confront a close-flying phalanx whose back was a bristling nest of machine guns, as dangerous to approach as a porcupine.

The A-20 can also be used for level bombing at higher altitudes, and even that does not exhaust its usefulness. It's a lot of plane in one package. A regular little death-dealing sweetheart!



"NEGATIVE ANGLE OF ATTACK" in the wings gives the plane its hunched-over look when at rest. In gaining speed for a take-off, it presses its nose down against the shock absorber on the front wheel at right. To get off the ground, the pilot has to pull the tail down sharply

Long protruding nose and high tail fin are earmarks of the A-20. In flight, the large landing wheels retract into engine nacelles



Vibrating Lens GIVES MOVIE CAMERA GREAT DEPTH OF FOCUS

For all-over focus effects, the oscillating lens can be used with a standard movie camera. Below, the arrow points to its round housing which is shown fitted to a standard camera in place of an ordinary lens

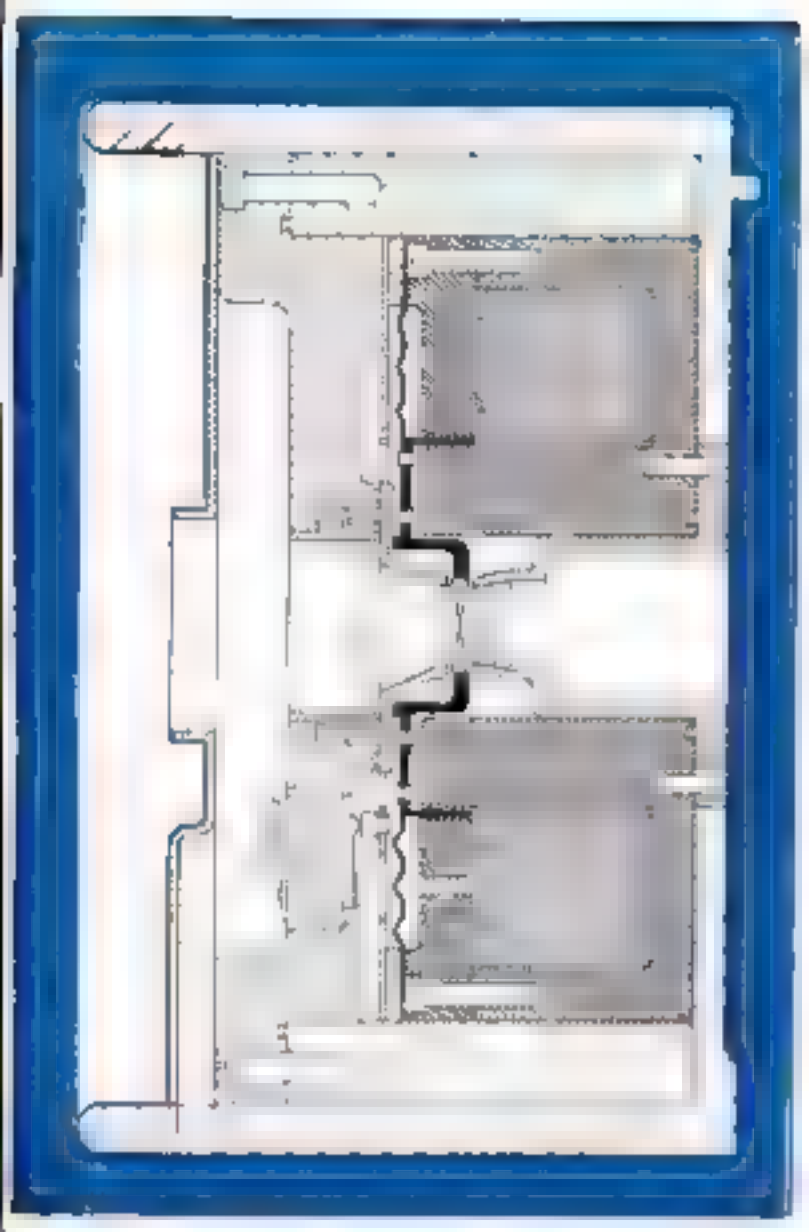
INFINITE depth of focus, bringing foreground and background objects in movie scenes within the customary range of the eye, is achieved by a new camera lens which is oscillated by an electromagnetic field. Continuous vibration while the camera shutter is open causes continual change of focus as the lens moves forward and back, superimposing on each frame of the film images that are in focus from four feet to infinity. For those viewing a movie, especially close-up scenes, this lessens eye strain, since the eye, which varies its focus rapidly in normal three-dimensional sight, can take in a focused background whilewavering naturally between it and the close-up interest.

The new lens system contains four lens elements and a vibrating circular armature housed in a metal casing which can be fitted on a standard movie camera. Three of the lens elements are stationary, but the fourth, a double-concave lens second in line from the front of the camera, is mounted in an opening in the center of the armature and is the oscillating unit. Through the application of alternating current, it can be vibrated as much as 23,200 times a minute in a confined distance of .3 of a millimeter. It is this oscillating lens that brings all near, far, and intermediate objects within focus on the same negative frame and produces the all-over focus effect.

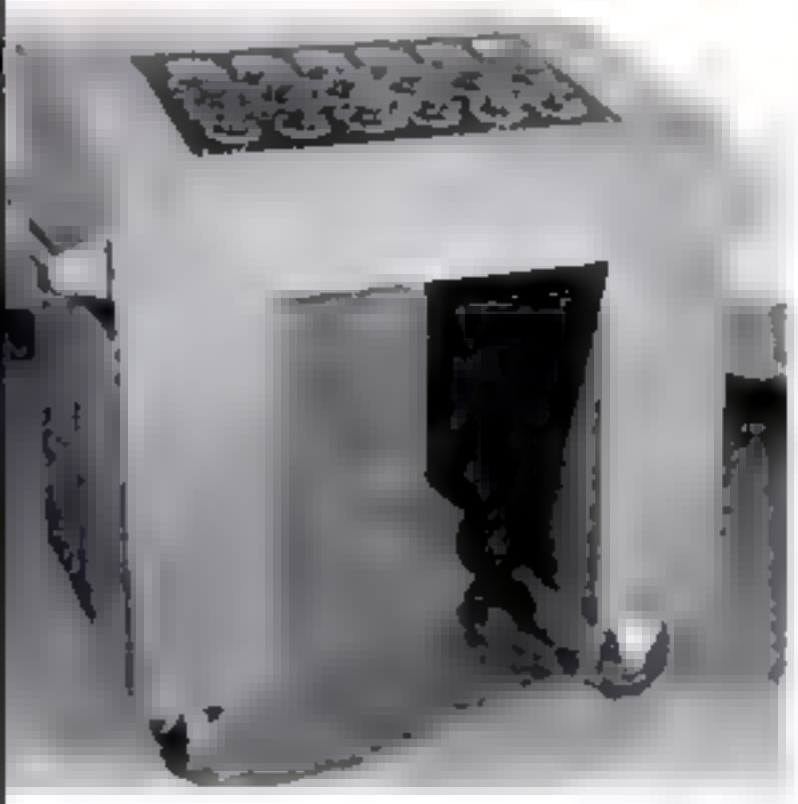
Superimposing focused and unfocused images upon themselves causes but slight diffusion in the finished picture. Vibrating at its highest rate with the shutter open for 1/50 of a second in normal use, the moving lens completes more than seven cycles, carrying the focus on each frame through all planes in a scene at least seven times. The resulting slight diffusion is said to be pleasing.

Both the rate of vibration and the distance the lens travels can be regulated from an electric control board. A decrease in the length of oscillation brings a corresponding decrease in the effective depth of focus. Lens movement is stopped altogether when the current is switched from AC to DC, converting the camera to use for a set focus.

On movie sets, the new lens system will allow greater freedom to actors, who now are required to work within chalk lines at the expense of blurred film. It should aid naturalness and reduce the cost of cutting. The arrangement was perfected by Philip Stanley Smith, a New York sound engineer. Its movement is noiseless so as not to interfere with sound recording.



Cross section of the oscillating lens unit. The moving lens is second from left, mounted in the armature opening

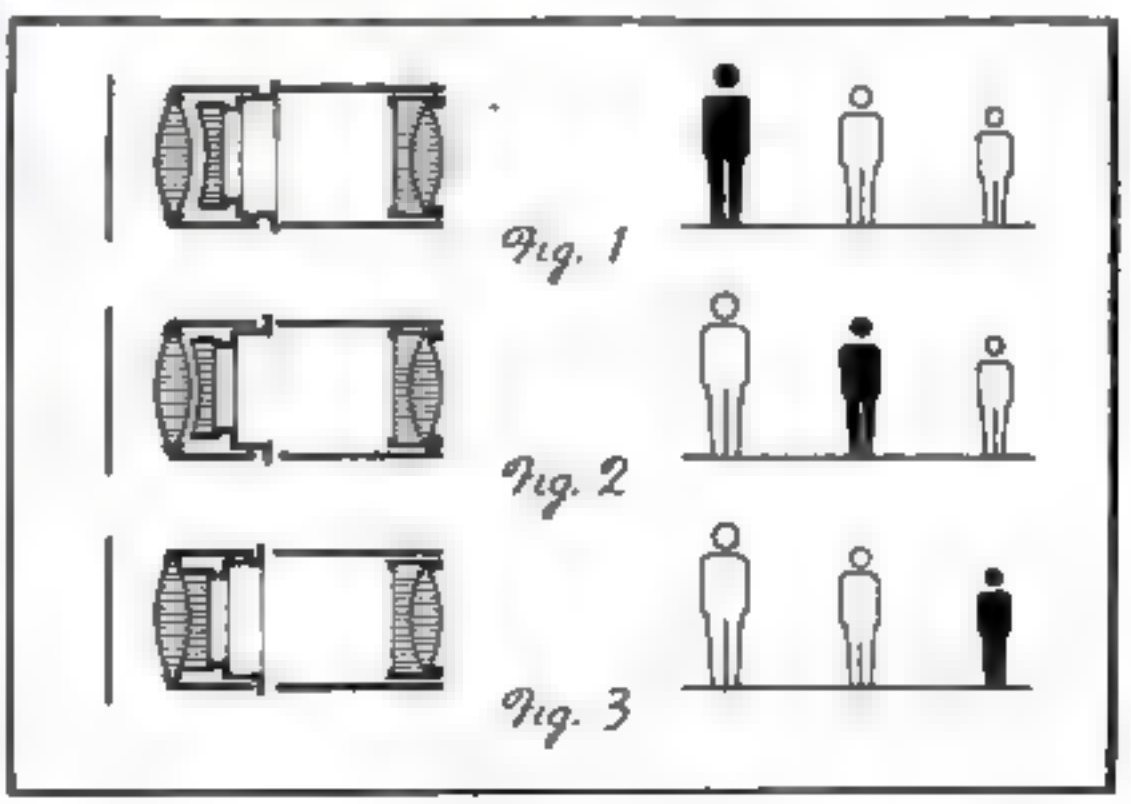


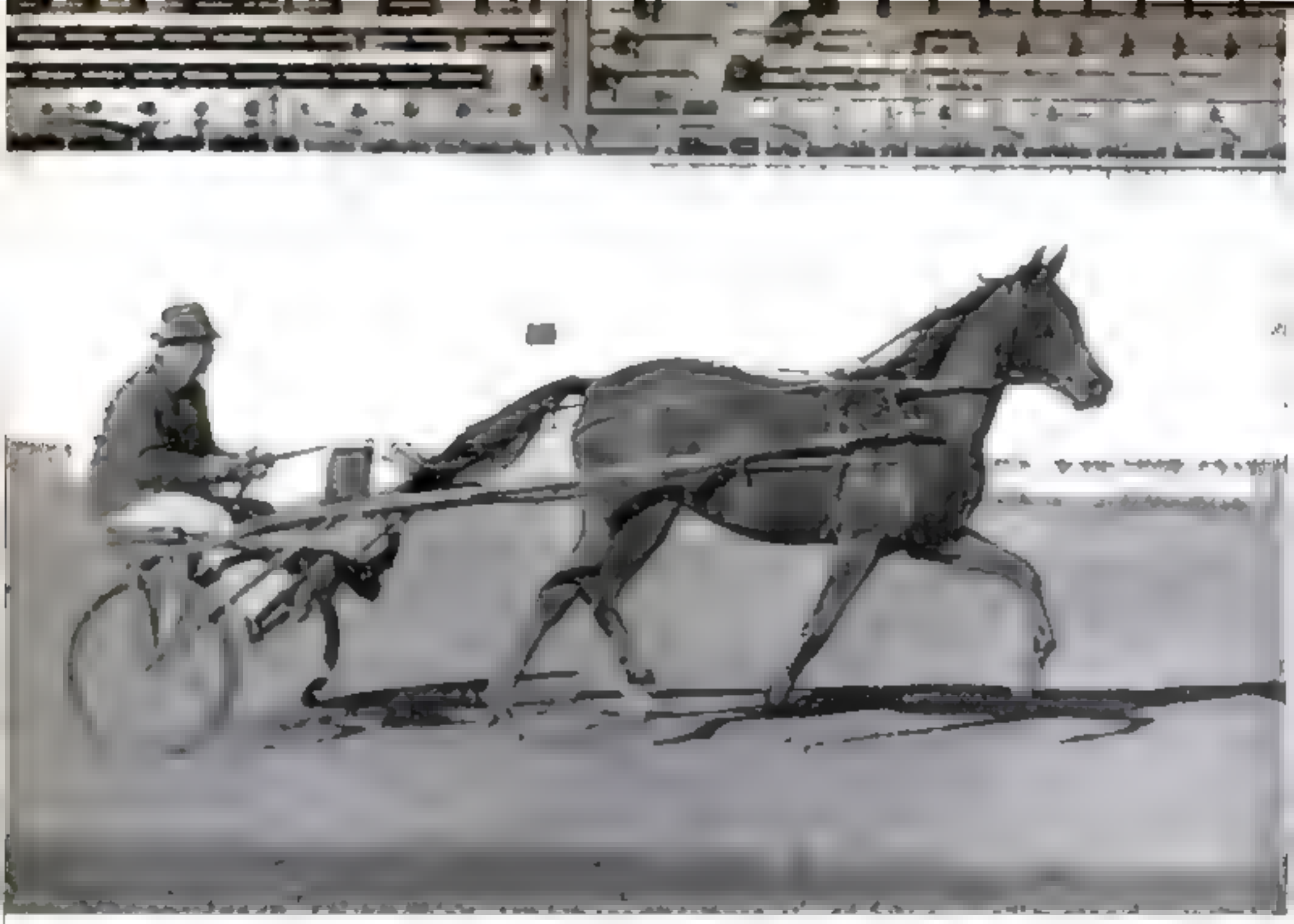
Rate of vibration and the distance traveled by the lens are controlled on this board to suit varying scenes

HOW THE LENS SHIFTS FOCUS. In Fig. 1, the vibrating unit is at one extreme in its cycle, that nearest the camera opening, and the focus is short, registering most clearly the foreground figure (shown dark). Next, the lens has moved back part way and focuses the central figure. At its other extreme, it focuses background

Enlargement from a 35-mm. negative frame taken through the new vibrating lens. Note the clarity of focus of the building in the background. Ordinarily this would show up badly blurred

Another enlargement from a 35-mm. movie frame shot through the depth-of-focus lens. The girl in the background and even the objects farther back are as clearly focused as the near figure





HOW IT IS DONE

Trotting form exhibited by this horse is the result of weeks of patient training, plus generations of inbreeding of harness racers

TRICKS THAT TRAIN TROTTERS

FIVE MONTHS OF HARD SCHOOLING PLUS $550 WORTH OF EQUIPMENT TRANSFORM A RAW YEARLING COLT INTO A FINISHED HARNESS RACER

—●—

By Barrett McGurn

HARNESS racing, which provides those picturesque classics of the county fairs, is in the midst of a nation-wide revival. Seemingly on the verge of vanishing from the American scene only a few years ago, this sport, one of the earliest in our country, is booming again. At every meeting in the last three years, attendance has been up. Purses have increased over 33 percent to more than $2,000,000 a year. Meetings have increased. About 6,000 harness horses will race this season. About 2,500 of them will be trotters, 3,500 pacers.

Behind these meetings is an industry. Training harness horses to race is a complicated job. It is not natural for a horse to trot or pace. His instinct tells him to run like the thoroughbred. But he can be bred to trot or pace and if breeding doesn't do it, he can be taught. That is what the harness-racing industry does. It breeds and trains and teaches horses and then races them.

Let us take a theoretical typical yearling through his training and onto the track at a big meeting. First fix in mind the difference between a trotter and a pacer. When you see a horse traveling with a diagonal, pincer gait, that is a trotter. Opposite front and hind legs move forward and backward together. The pacer's gait is ambling, later-

al. The two legs on one side are forward while the two opposite ones are back. Elephants are pacers, crawling babies are trotters.

Each November the breeding farms hold auctions of yearlings born in the previous year. The birthday of all race horses is January 1, no matter when they are actually born. About 400 yearlings are bought at four big sales. Those who buy them are taking part in one of the biggest gambles in sport. There is little or nothing to tell a trainer if the yearling he buys will be a winner or a flop. He goes by pedigree and physical appearance. These are the only clews. Some of the biggest money winners went for peanuts at the yearling sales.

The theoretical typical yearling our trainer buys is no harness horse. He has been broken only to the halter and in five months he must be ready to race as a two-year-old. So the first thing the owner does when he

1 GROUND BREAKING. First step in training is to walk the yearling around the stable lot. While the trainer takes the reins, his assistant holds a lead strap in case the horse tries to bolt

2 BREAKING CART. After ten days of ground breaking, the animal is hitched to a cart resembling a racing sulky but heavier. An assistant, for safety's sake, still has a lead strap on the horse

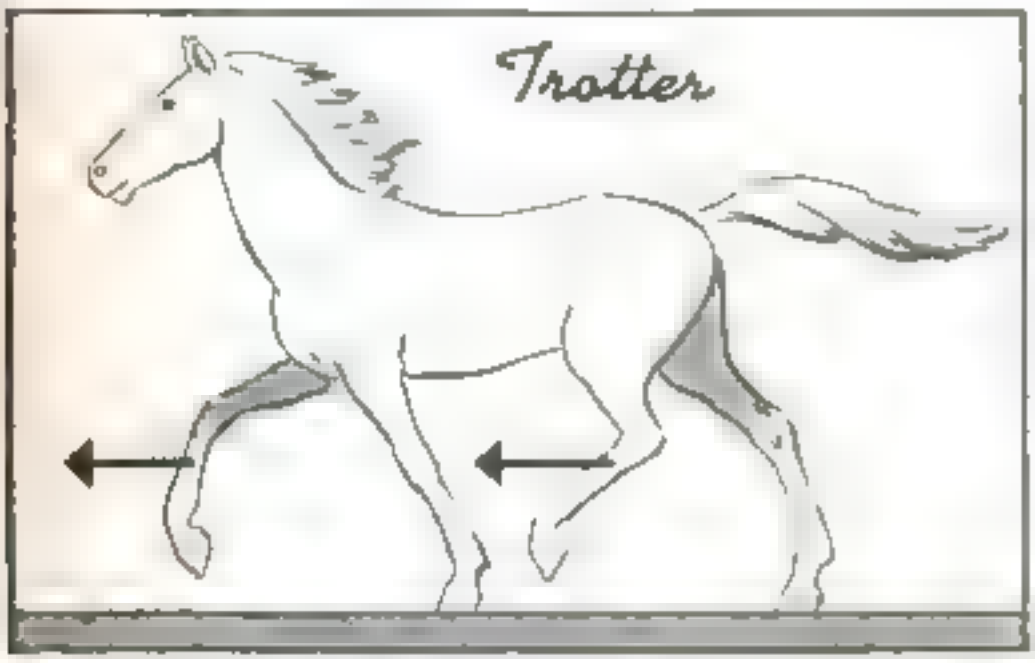
gets the colt home is to put a harness on him and turn him loose in a stall. This is a critical moment. The horse may break his neck. If he doesn't he is led out of doors in harness, but without a cart. That is called ground breaking.

The young trotter always resents restrictions on his freedom. He rears and bolts if he can. When he calms down he is driven, with the driver walking behind and one or two extra men holding onto lead straps. Tugs to the right and left introduce the idea of control into his young life.

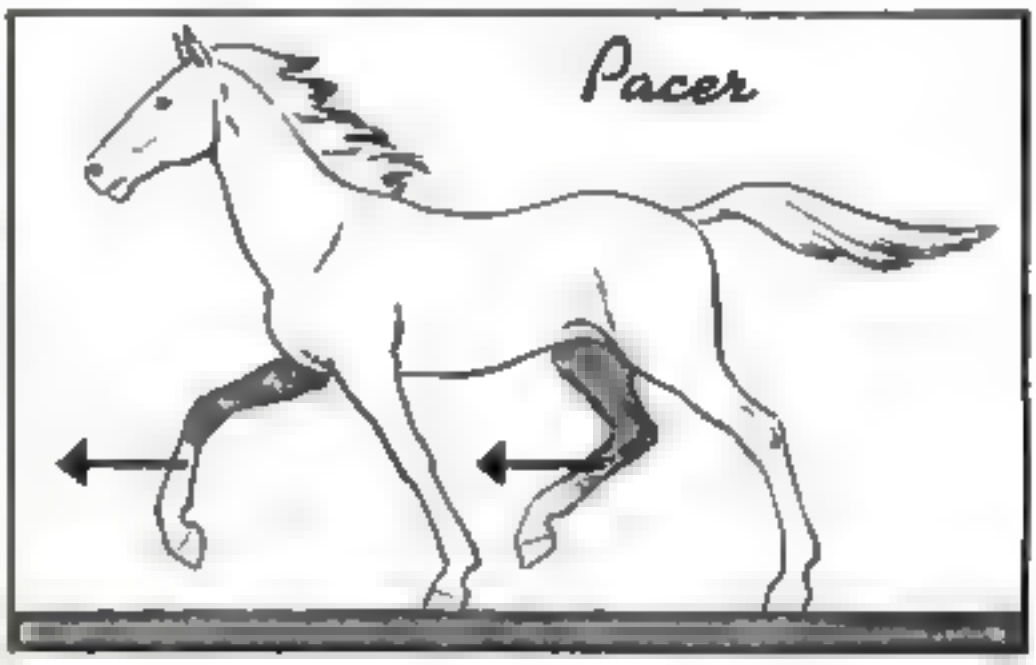
Our particular yearling may not take to trotting or pacing. If not, he has to be helped by mechanical means. For this, toe weights are placed on his fore feet to "square up" his gait and keep him on it if he is to be a trotter. For a pacer, hopples are used.

The weights make him lift his feet higher and punch them out straighter in front of him. By adjusting the weights he can be brought into the exact gait desired. The pacer's hopples are leather straps linking together the front and hind legs on either side. Hopples may also be used on a trotter if he proves stubborn. For him the straps link forelegs with opposite hind legs.

Many times it is even necessary to

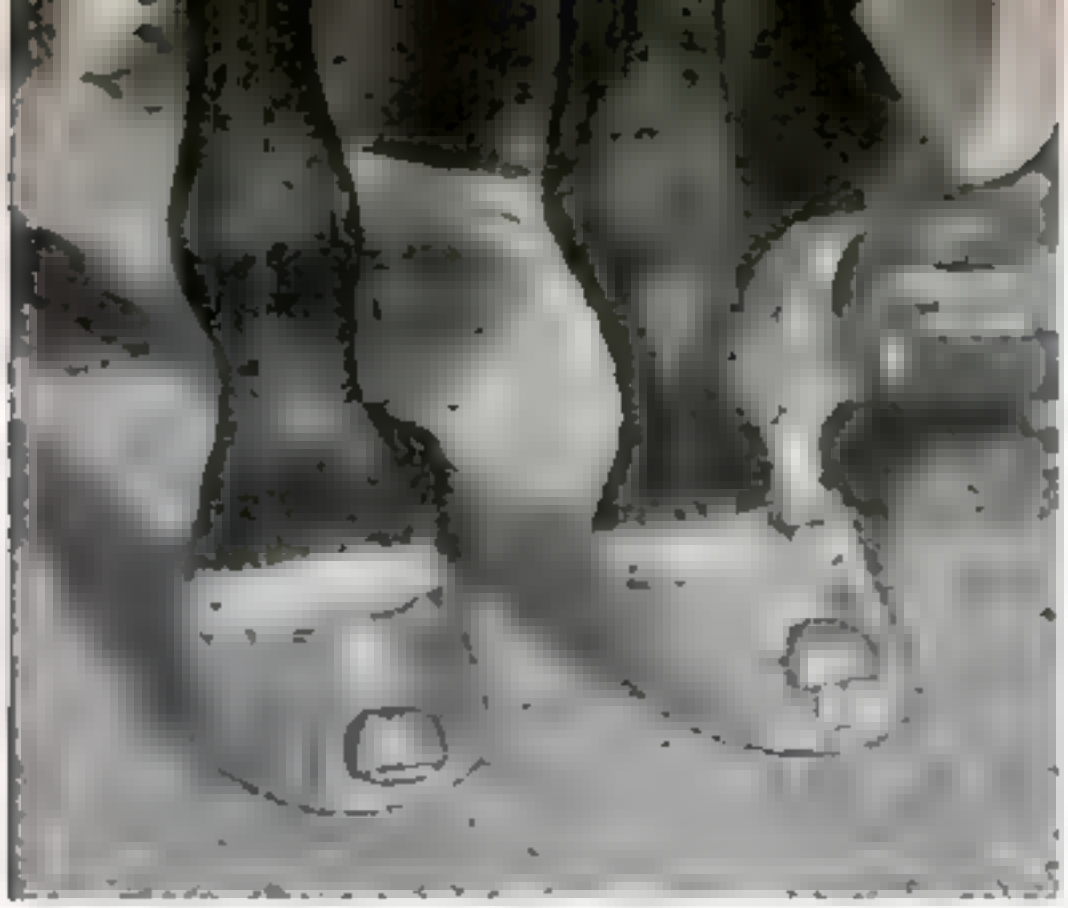


TROTTER uses a diagonal, pincer gait, putting right foreleg and left hind leg forward at the same instant, while the other legs extend backward

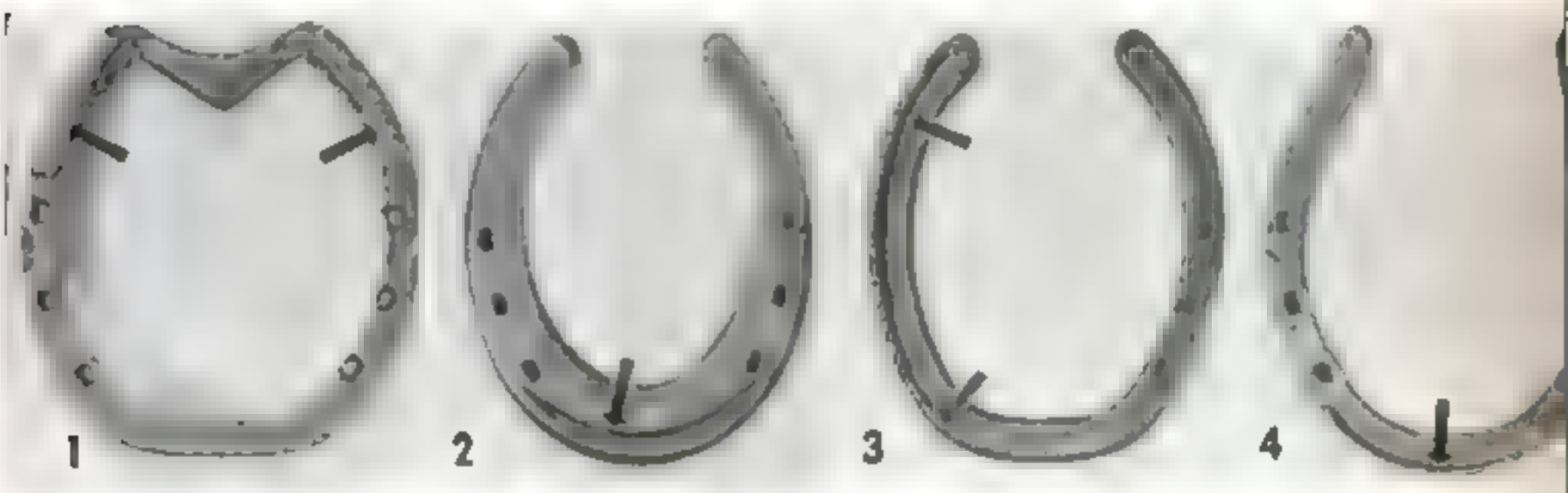


PACER puts the two legs on one side forward while those on the other side are back. The result is an ambling, lateral movement known as "sidewheeling"

ON THE TRACK at last, the horse is brought to the trot for the first time. Three times on each day's jog he is made to trot for a sixteenth of a mile, to get a taste of the career ahead of him



TOE WEIGHTS are used to square up the gaits of trotters that do not trot naturally at first. These are pieces of brass that are slipped onto metal spurs screwed onto the front hoofs as shown at left above. Another gait-correcting device is a rubber sleeve that is slipped over the hoof to add weight



SPECIAL SHOES rectify faults. (1) Hind shoe for trotter with square toe and wedge heel, to raise the heel and shorten stride of hind legs. (2) Crease toed fore shoe for trotter, to grab dirt and keep foot from hitting elbow. (3) Front shoe for trotter or pacer with half swedge to keep hoofs from hitting knees. (4) "Circle grab" hind shoe for trotter slows up hind legs to let the forelegs get out of the way

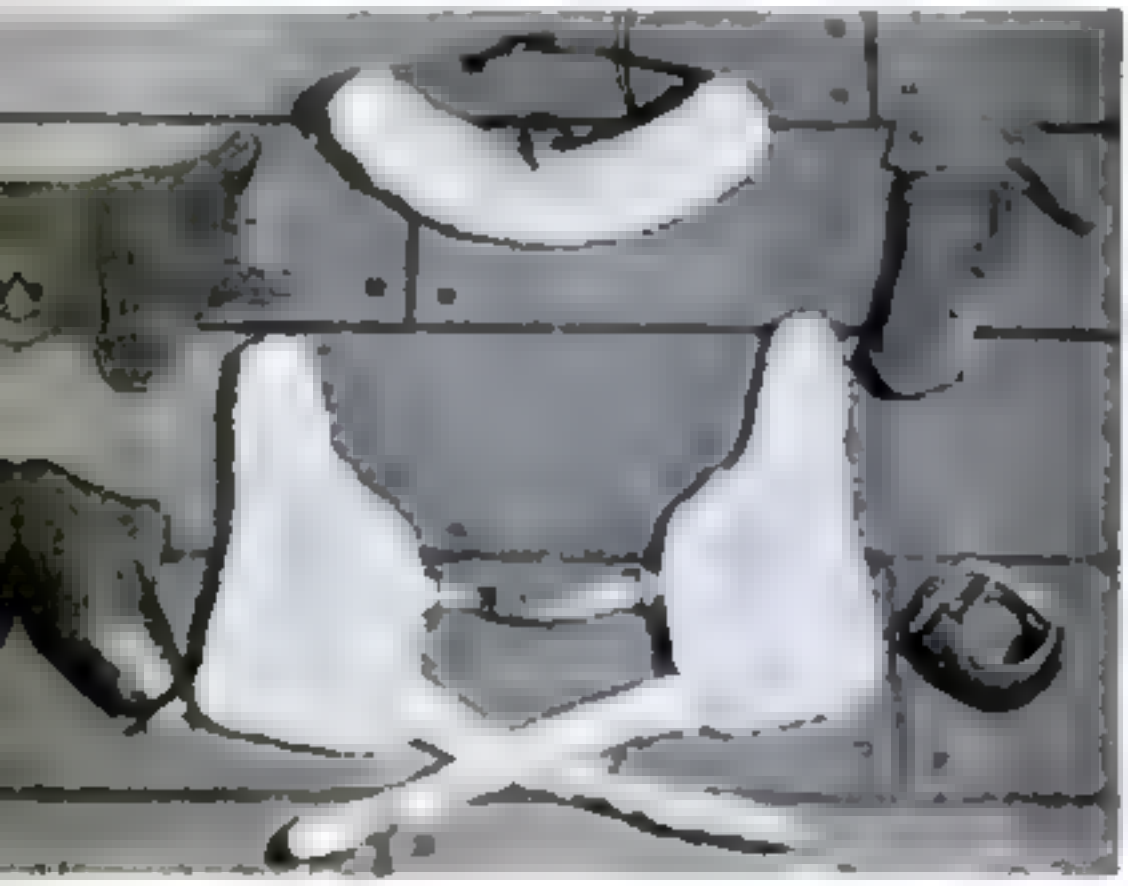
NARROW FEET which would spoil a colt for harness racing are remedied by inserting a V-shaped steel spring into the sole of the foot. Gradually pressing out the sides of the hoof, this can add as much as an inch to the width of the horse's foot

pressure a racer permits to make up yearling a racer. Many colts have narrow feet with contracted "heels" and hoofs growing under and pressing in the frog. To remedy this, a V-shaped steel spring is inserted into the sole. As much as an inch can be added to the width of the hoof in this way

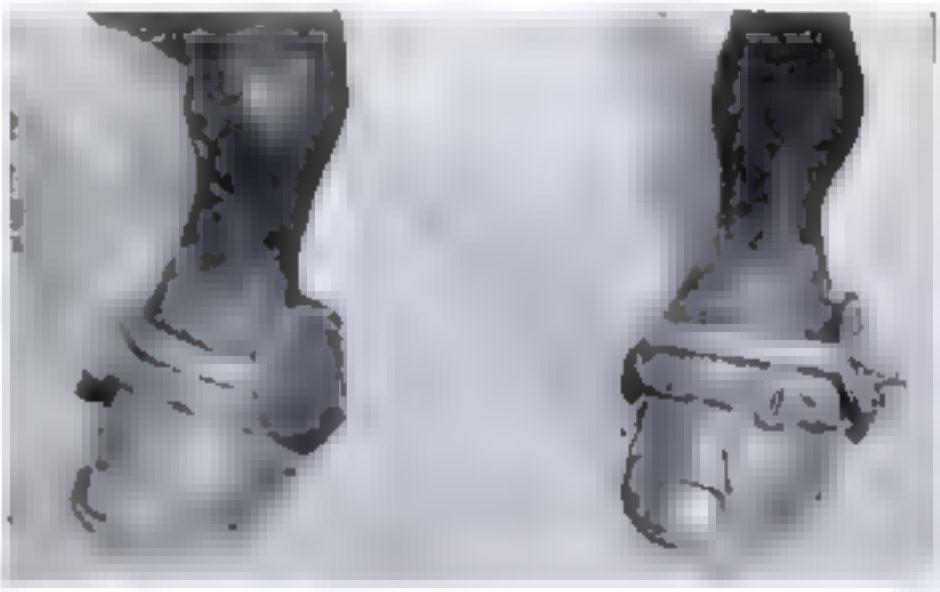
These defects the trainer discovers in the first three weeks, during which the colt is being prepared for the breaking cart, a rough, heavy version of the racing sulky. He begins correcting faults immediately and has to keep it up right through the training period. After a few days of pulling the cart, the yearling is used to the idea and he is required to jog ever-increasing distances until he reaches three miles a day.

Two weeks of this and the weather is getting cold. The colt probably will be taken to Florida to winter. There his training continues. He is brought to a trot, a few rods at a time, a few

A SAWED OFF BILLIARD CUE is part of the harness equipment of some horses that have a tendency to run with their heads to one side. Strapped to the side of the head it keeps the rump in line



BOOTING UP protects harness racers from injury due to hitting themselves. At left is some of the equipment used. The woolen arc at top is a shadow roll strapped over the nose to cut off shadows on the track. Below are protective pads worn on the front hoofs



Many trotters strike the rear ankles with the front hoofs. Leather coverings strapped over the hind ankles, as shown below, are the remedy for that

Some high steppers bring their front feet back so far that they actually hit the upper part of the same leg. Wool-lined "elbow boots" are used in such cases to prevent serious injury

Boots on knees and shins take care of a horse that hits one foreleg with the other. No more boots are used than are needed, because weight is a handicap

HEAD CHECK. Most harness horses wear a strap running from the saddle over the top of the head to the bit, to keep them from taking hold of the bit, sticking the head out, and racing out of control of the driver

READY TO RACE. With training finished, the colt is given a tryout on the track. Selecting a horse for training in championship racing is one of the biggest gambles in sport. A colt that looked good at the auction sales may fail to make good on the track, while one that sold for as little as $600 may earn thousands

more each day. By January he takes to the racing sulky and he trots a quarter mile in about 40 seconds. By February 1 he does it in 35 and on or about March 1 he is put to a mile, which he is required to trot in about 2 minutes 20 seconds, the last quarter in 33. By April 15, if he has measured up, he is put to a mile in 2:15 and he is ready to race. By fall he probably will be doing a mile in 2.02.

He is now ready and he is going to see a lot of the country. He will go on the Grand Circuit, a series of meetings in cities from Maine to Wisconsin with purses totaling $1,000,000. Meanwhile the eyes of his owner will be on Goshen, N. Y., home of the Hambletonian, harness racing's classic for three-year-olds with a purse of $50,000.

During the off season, from November to April, the horse costs $60 a month for trainer, groom, and feed. During the racing season in the remaining months, a first-class trainer received $90 a month and a groom $75. Shoeing comes to about $6 a month and stake payments run from $900 to $1,300.

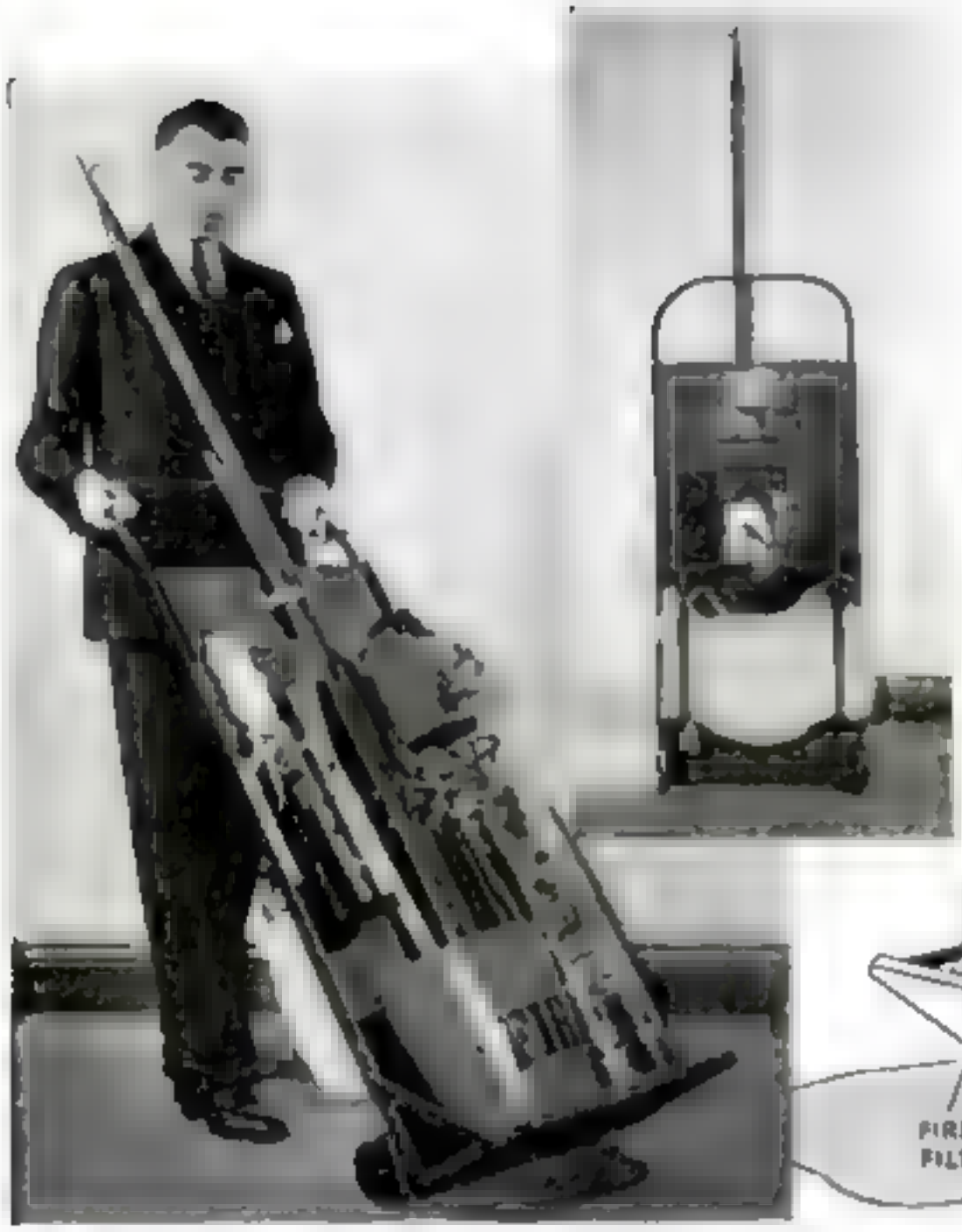
The horse's feed bill averages about a dollar a day. Winter and summer he has three meals: 5 a.m., 11, and 4:30 p.m. The first two consist of about two quarts of oats each, and the last of two quarts of bran and two quarts of oat mash soaked in water. Occasionally potato and apple peelings, handfuls of corn, and perhaps three or four carrots a day, serve to liven the fare. The horse has hay in the stall all day, and a salt lick in the corner.

The pacers are slightly faster than the trotters. Every decade in the past 100 years, as records have been bettered, the "sidewheelers" have managed to stay a fraction of a second ahead.

A colt costs its owner from $3,000 to $3,500 a year plus about $550 for equipment, but he has a good chance of paying his way. About 35 percent of all two-year-olds win enough to do that. After a year, his chances increase, for 65 percent of the older horses pay their way.

If he does not pay his way he probably will not be racing another year. If he does, he may race for 12 or even 15 years and live to be 30 years old. It is not a bad life for a horse.

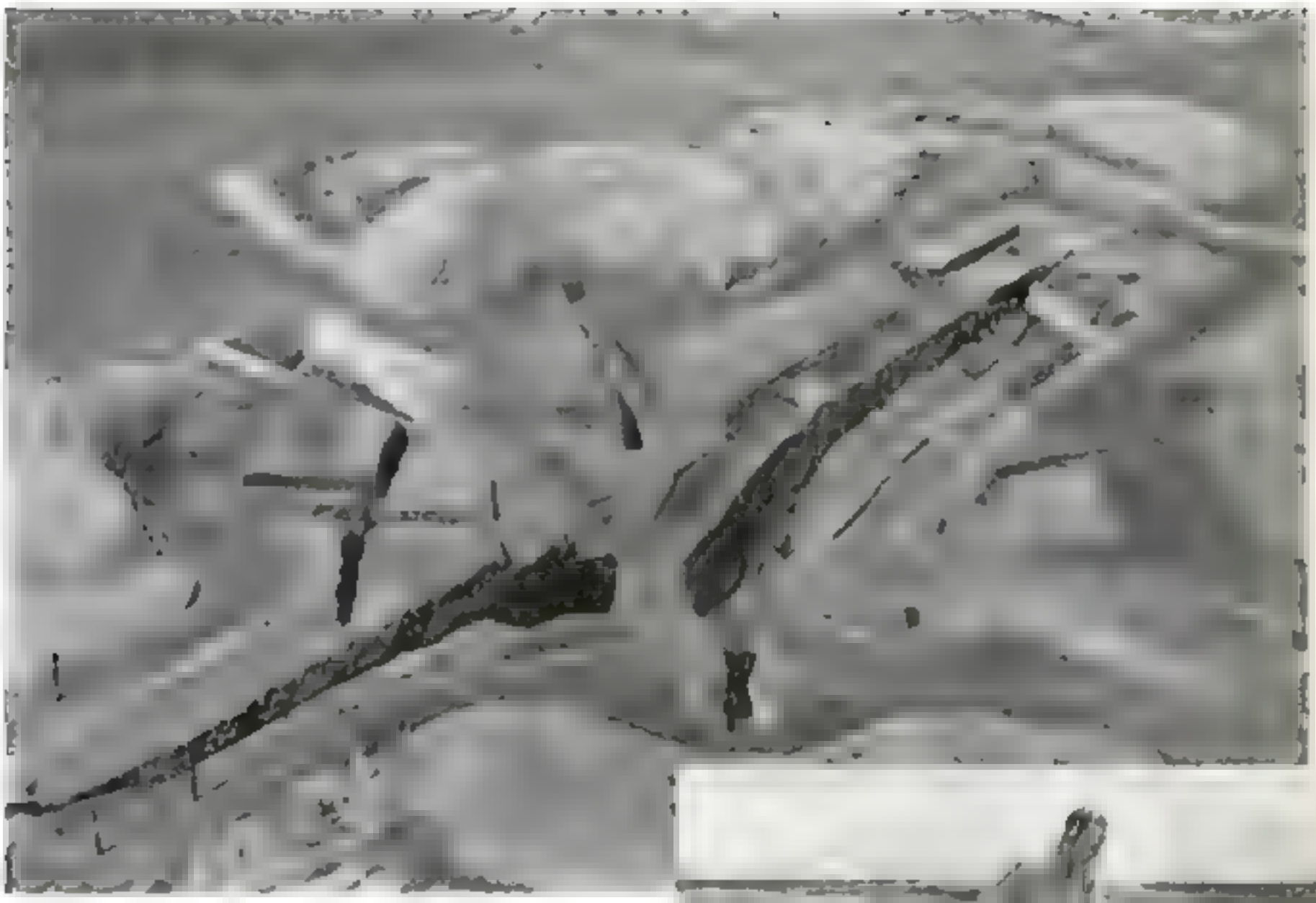
Air-Raid Fire Cart for Office Building Is Model for Homes



AN OLD filing cabinet furnished parts for the air-raid emergency fire truck which Edward W. Stein, New York City building superintendent, made for the building where he is employed. Stein believes anyone handy with tools could duplicate the hand cart for home or other use. The front and back views above reveal the equipment on his unit, while at right is an artist's drawing of a cart and suggested equipment for homes. Because of the weight of the fire-fighting apparatus, the wheeled cart should be made as light as is consistent with strength.

Blackout Signals for Military Police Make Him a Walking Traffic Light

WHAT Army traffic cops may soon be wearing for blackout duties is illustrated by the soldier at the right equipped with a special flashlight baton and shoulder lights, as well as reflecting elements on his ankles to catch the low beams of cars with blackout headlights. The baton flashlight shows up as simply a glowing band of amber light. The shoulder lights, powered by an electric battery worn on a belt, display red lights in front and back and green on the sides, enabling the traffic officer to give directions merely by doing left and right face.



Excavation on the rim of Texas b g meteor crater. The original hole is 500 feet n diameter and 50 deep. The meteorite may be 164 feet farther down

Meteorite Diggings Show

BIG CRATER

Blasted with Air-Bomb Force

PROOF that prehistoric America was subjected to much the same aerial bombardment that now holds forth in the war zones has been uncovered on the plains of Texas. In Ector County, lying near this country's second greatest meteorite crater, are two more only recently brought to light. The larger, some 70 feet in diameter and 17 feet deep, contains 6,000 to 7,000 meteorites with a total weight of probably six tons. All three crashed about 40,000 years ago with a terrific speed resulting in a concussion comparable to that of huge detonation bombs. It is estimated that rock strata from as deep as 70 feet were thrown to the surface by the impact, those now forming the crater walls being lifted, broken, folded, and faulted. The main crater has been drilled with 35 exploratory holes through silt and sand. When excavation is completed by the University of Texas and the WPA, the sites will be maintained as educational exhibits open to the public.

Hunting fragments of the meteorite at the edge of the crater with a homemade metal locator. This instrument is effective to a depth of three feet

These workers in an exploratory drill hole are putting plaster around a fragment of meteorite in preparation for bringing it safely to the surface

A deserted city in the Indian jungle, as re-created in miniature for the filming of Kipling's "Jungle Book." At the right fire sweeps the model in a realistic scene

Movie Makers Build Model Jungle City For Big Fire Scene

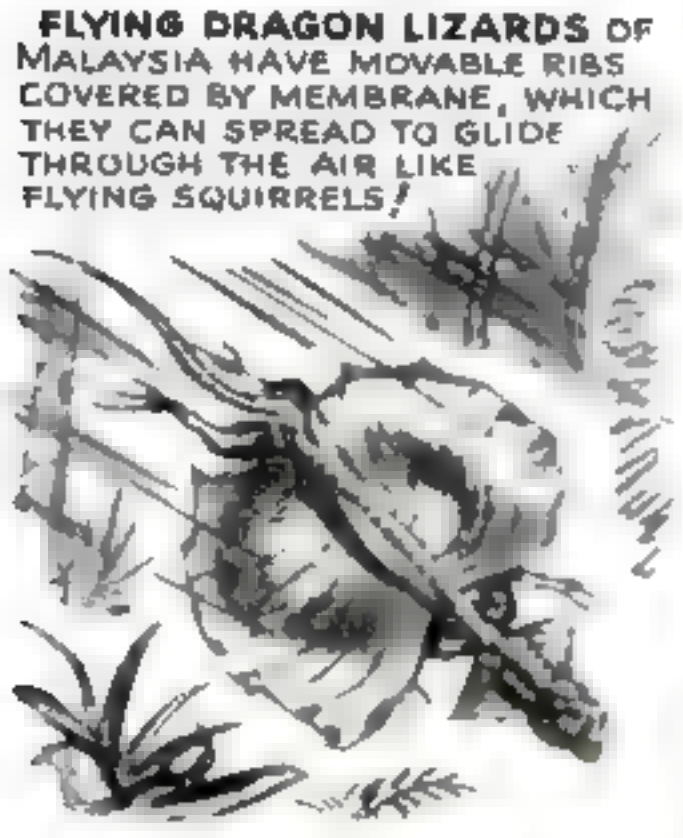
MOVIE-goers seeing a film version of Rudyard Kipling's "Jungle Book" will be thrilled by the sight of a huge deserted city being destroyed by fire in the Indian jungle. Actually this fabulous fire-swept city was built in miniature in the space of one third of a city block in a man-made jungle" 20 miles north of Hollywood To make the spectacle more realistic, director Alexander Korda set up wind machines, powered by automobile engines, to blow smoke across the set. Reflectors kicked light into the smoke so that the comparatively small fire was transformed by the mechanics of deception and the art of the camera into an all-out blaze, horrible and devastating. When this carefully constructed miniature city had been satisfactorily destroyed, the task of photographing the scene was only half completed. To film scenes of actors in the city a full-size set was built at the studio. Part was a painted curtain on which the ruined buildings and forest faded into the distance.

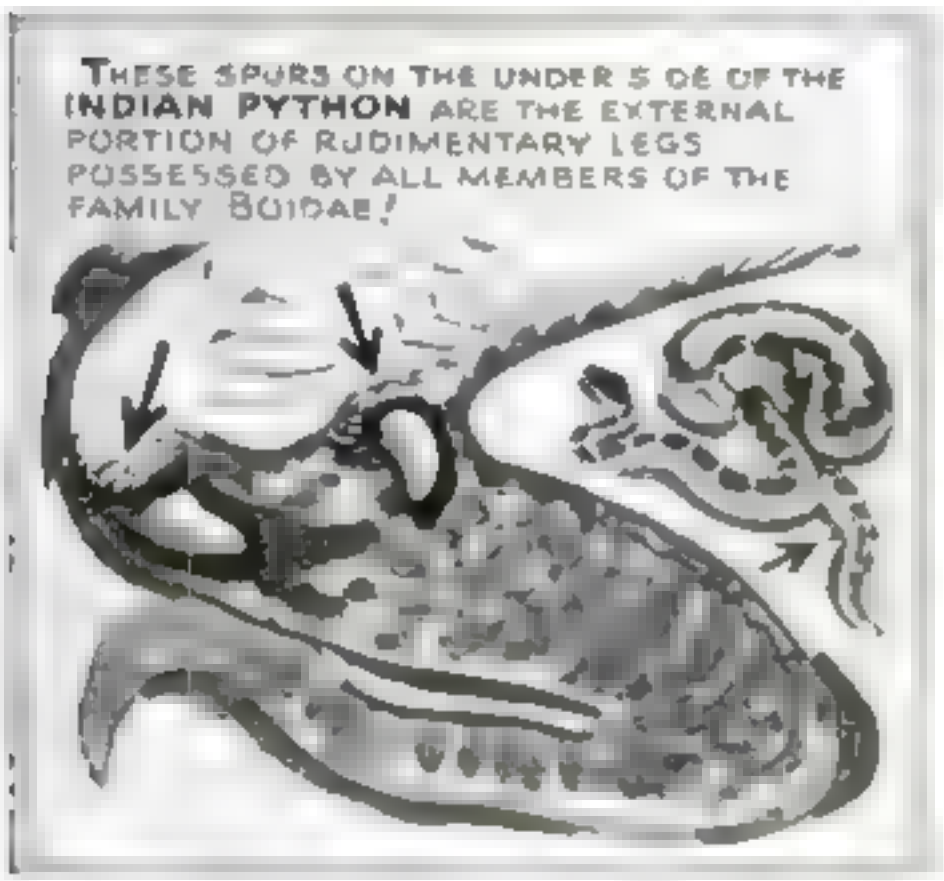
To add horror to the conflagration, smoke was blown across the set by motor-driven wind machines. Scenes involving actors were enacted upon a full-size set with painted backgrounds for depth

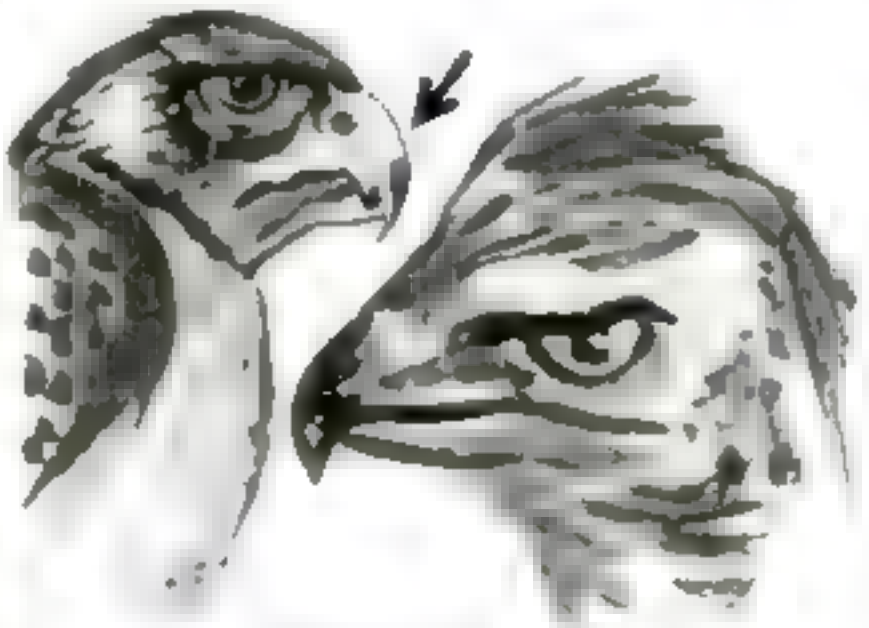
POPULAR SCIENCE

Un-Natural History

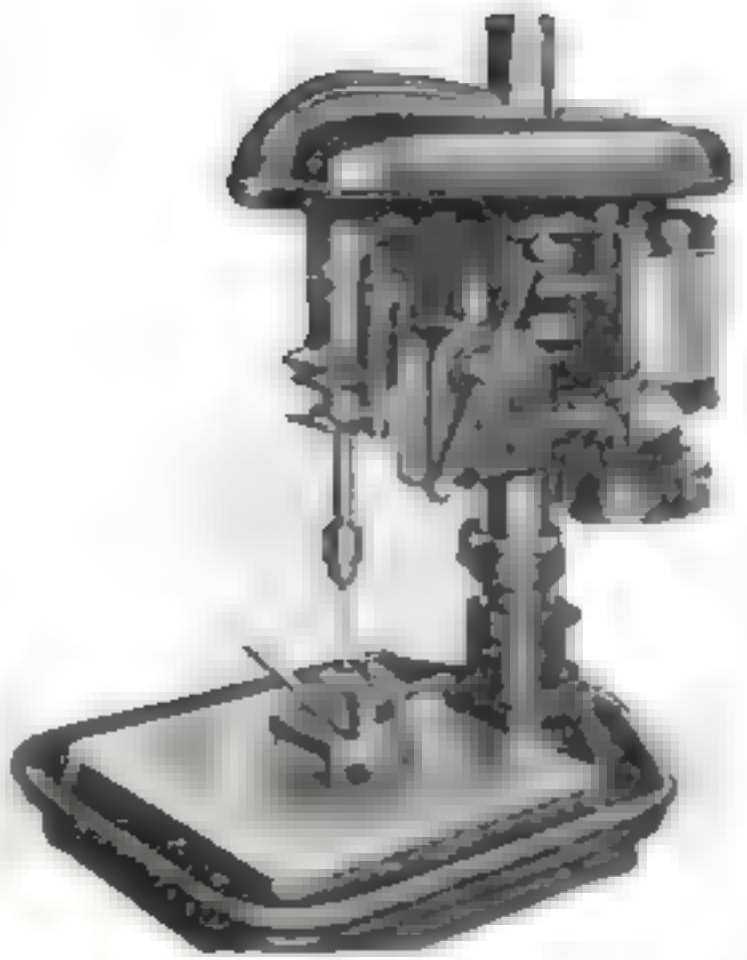
BY Gus Mager





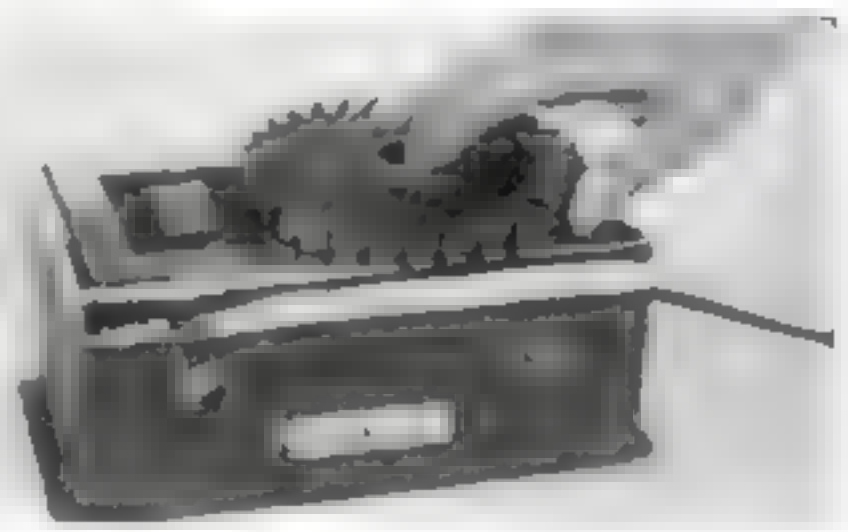


new Tools



POWER-FEED DRILL PRESSES in the low-cost bracket are now available with an improved power-feed unit operating directly from the bottom drive to increase the feed range. The mechanism can be regulated in slow-speed drills to feed from .001 to .016 inch per revolution of the spindle and in high-speed machines from .0005 to .009 inch per revolution. Two four-step cone pulleys and a special belt-tension release control safe speed changes.

A PORTABLE DEMAGNETIZER has been developed for use on the workbench to demagnetize tools and machined parts that have been held in a magnetic chuck. Small pieces are said to be completely demagnetized after a single passage across the poles. Bulky work may be demagnetized by passing the machine over them. The demagnetizer is $10\frac{1}{2}$ inches long by $5\frac{1}{4}$ inches wide and $4\frac{1}{2}$ inches high and weighs 17 pounds. A standard model operates on house current at 115 volts, with other voltages available.



AUTOMATIC VISES, quickly adjustable by means of foot pedals, are on the market as a time and labor saver for shops. One pedal on the device exerts sufficient pressure between the clamps for general work. For additional pressure for special jobs, there is a small auxiliary pedal below the main pedal. This new vise, taking up little more space than the screw type, can be mounted either directly on the workbench or on a movable stand.

EXTENSION SPRAY GUNS are being used for painting large surfaces, such as railroad cars and ship hulls, without the necessity of frequent adjustment of scaffolding and staging. With extension units supplied in lengths up to 12 feet, an operator can cover the average wall and ceiling from the floor. For painting on lower levels, there are a detachable gun-grip control and several different lengths of shaft designed for use in the same grip. The shafts turn readily in the grip so that the spray can be aimed in any direction.

INDUSTRY GOES IN FOR Vitamins

To Conserve Manpower for Defense Work

Archie R. Olsen, a mechanic at a Lockheed Aircraft plant, takes time out to swallow a vitamin capsule. He is one of 1,300 Lockheed and North American Aircraft workers taking part in a test

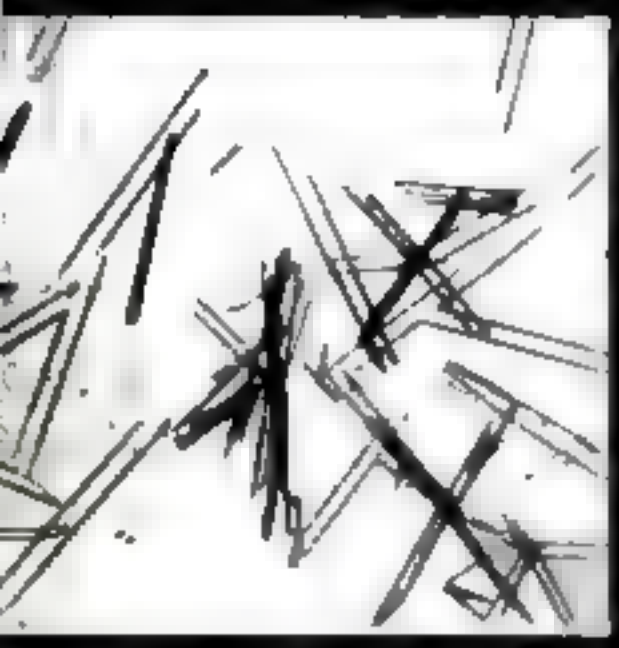
By KENNETH M. SWEZEY

FACING the biggest production program in its history, American industry suddenly has become vitamin-conscious. As part of an all-out attempt to improve the general health, energy, stamina, nerve-coordination, and eyesight of workers, a half dozen great defense plants already are feeding vitamin cakes and capsules to men who make aircraft engines, instruments, pursuit ships, and bombers. Under careful medical supervision, about 4,000 men and women are now taking part in these mass experiments—with perhaps 100,000 soon to follow if the results meet expectations.

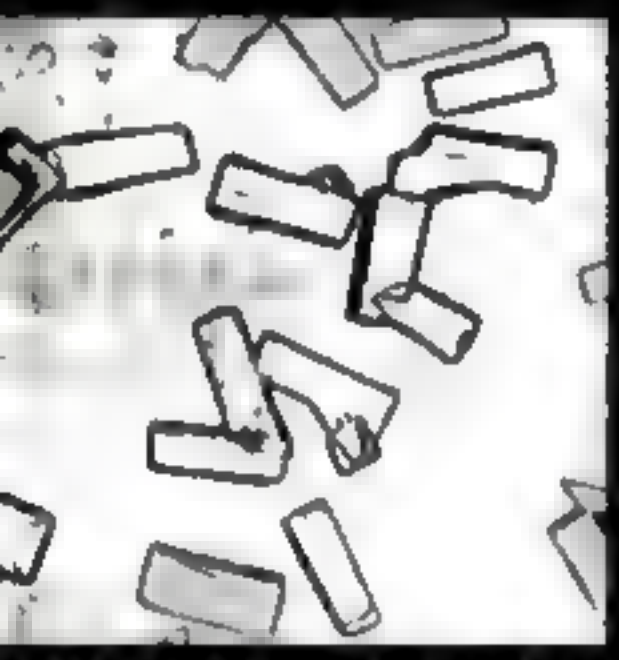
More vitamins for workers, by means of vitamin-rich natural foods, foods artificially fortified, synthetic crystals, and vitamin concentrates, is the plea of the National Association of Manufacturers. This organization, representing 9,500 companies, has launched a nation-wide educational campaign to enlist the 15,000,000 women who prepare the meals for the men in the nation's factories. Leaflets, posters, newspaper articles, point out to housewives the foods richest in vitamins, and the best means to preserve these vitamins in cooking. Usefulness of drugstore vitamins is explained to those who do not care to change their diets.

Neither food fad nor philanthropy, this first large-scale utilization of vitamins by industry has a thoroughly practical objective. Even in normal times, personal disabilities—

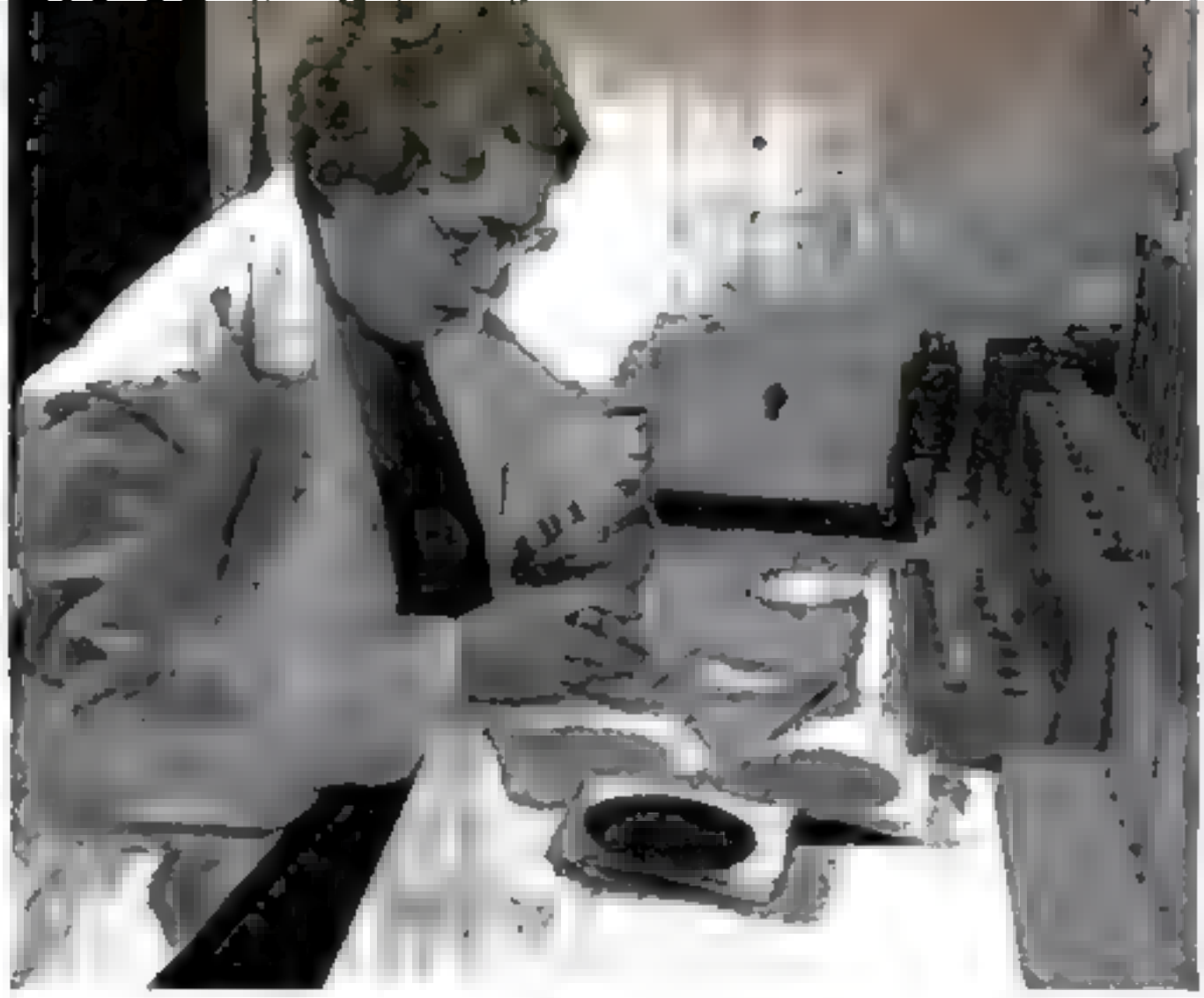
VITAMINS AS SEEN BY THE MICROSCOPE. Photomicrographs show characteristic crystal forms by which compounds are identified



VITAMIN B-1 (thiamine hydrochloride) crystallizes from alcohol-and-water solution as long, needlelike crystals. Dark-field illumination used on microscope



VITAMIN C (ascorbic acid) is a white, odorless powder. Crystals occur as rectangular parallelopipeds. Products containing it must be protected from light, air



Thorough before-and-after health check-ups show how workers benefit from vitamin therapy. Here a technician takes a blood count by the swift and accurate method of punching photomicrographs of the cells

mostly common illnesses, such as "colds," influenza, gastro-intestinal disorders, and so on—cost industry from 350,000,000 to 400,000,000 man-days a year. Turned to war production, this lost power could build 52 battleships, 164,706 combat tanks, 45,000 bombers, or 107 average-size cantonments. Man-days lost by inefficiency due to sub-normal health would probably add hundreds of millions to those lost by actual absence. The strain of 24-hour-a-day operation of defense factories now makes such amazing figures jump still higher. If it is possible to save even a small percentage of this lost manpower by fighting fatigue, inefficiency, and illness with scientific nutrition, it means saving human lives and shortening the war.

Part of a nation-wide survey of industrial nutrition being made by the Government, the biggest single vitamin experiment began last November at the plants of the Lockheed Aircraft Corporation and North American Aircraft, Inc., at Burbank and Los Angeles, Calif. Twice every day,

NICOTINIC ACID crystallizes readily from water solution with a dendritic or treelike growth. A vitamin belonging to the B complex. Stable to light and heat

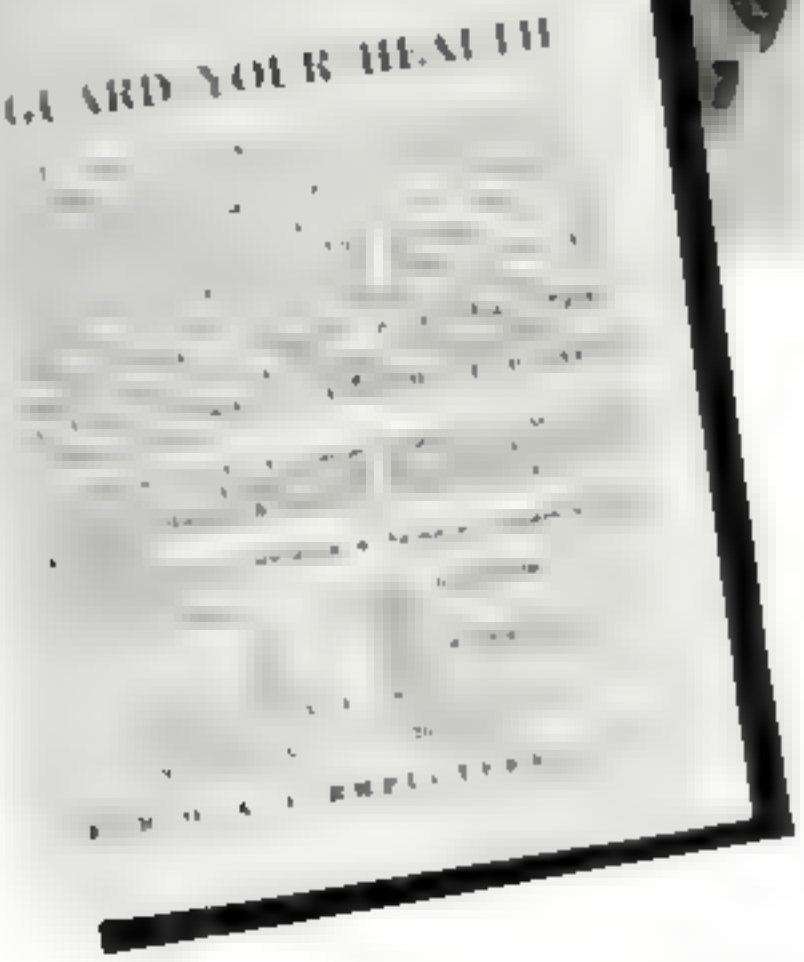
VITAMIN B-2, OR G, chemically known as riboflavin, is a powder composed of fine, orange-yellow crystals. Original photomicrograph made at 600 diameters

VITAMIN B-6. These crystals are parallelopipeds, but differ from those of vitamin C in that they are not rectangular. Soluble in water, they taste salty

Photomicrographs courtesy of Merck & Co., Rahway, N.

One of 600 office workers of the Westinghouse Transformer Division at Sharon, Pa., takes a vitamin pill out of a handy dispenser

Below is a paper cup distributed to employees of DoAll Co., Des Plaines, Ill., with daily capsule



shortly after four and a few minutes before midnight, 1,300 swing-shift workers take from trays borne by messengers capsules packed with vitamins and minerals. Under the watchful eye of the tray carriers, they wash down the capsules with a swallow of water and turn back to their jobs. For nine months they will eat as they have always eaten, changing their diet only by the addition of concentrated vitamins and minerals. At the end of the test the workers' health will be compared with its status at the beginning.

No physical examination costing less than $100, privately obtained, could be as thorough as the before-and-after check-up given these men at Lockheed. Heart, lungs, eyes, mouth, tongue, skin, blood, and nervous system are gone over. Blood is examined for color and hemoglobin content by a photoelectric colorimeter. Tests for deficiency in vitamins A and B-2 are made by means of a slit lamp, an instrument with which a doctor examines the front membranous lining of the eyes. Because the condition of this membrane reflects the condition of all the lining membranes of the body, the examiner can estimate accurately the total need of these two vitamins.

So thorough and carefully controlled is every phase of this pioneer nutritional experiment that every gain, change, or loss derived from vitamin feeding can be evaluated. Working as true scientists, the experts who are conducting this research predict nothing. But if hopes come true, workers will soon be able to perform their jobs faster, more efficiently, and with greater enthusiasm; their total health will be better, and life itself will be more enjoyable.

An important experiment, demonstrating the use of vitamin A in fighting colds, took place in the plant of Continental Machines, Inc., Minneapolis, Minn., last winter. Leighton Wilkie, president of the company, which makes machine tools, had been "sold" on the efficacy of vitamins by years of personal experience. The company doctor concurred So one morning in the middle of December, 1940, during the 10:30 rest period, each of the 350 employees received a paper cup containing a capsule. On the cup was printed a catchy health slogan. Each capsule was packed with 10,000 international units of vitamin A, 1,000 units of vitamin D, as well as small amounts of B-1 and B-2 (or G).

Every day until March 31, workers received these capsules, each day with a different slogan. Although there were two or three severe epidemics of colds and influenza in Minneapolis that winter, the highest number of workers absent at one time, due to illness, was eight—the best record, by far, ever run up by the company. In some winters, more than half the employees had been absent from work during the month of

To test for vitamin deficiency, the front membranous lining of a subject's eyes are examined. The eye membranes show condition of all body lining membranes

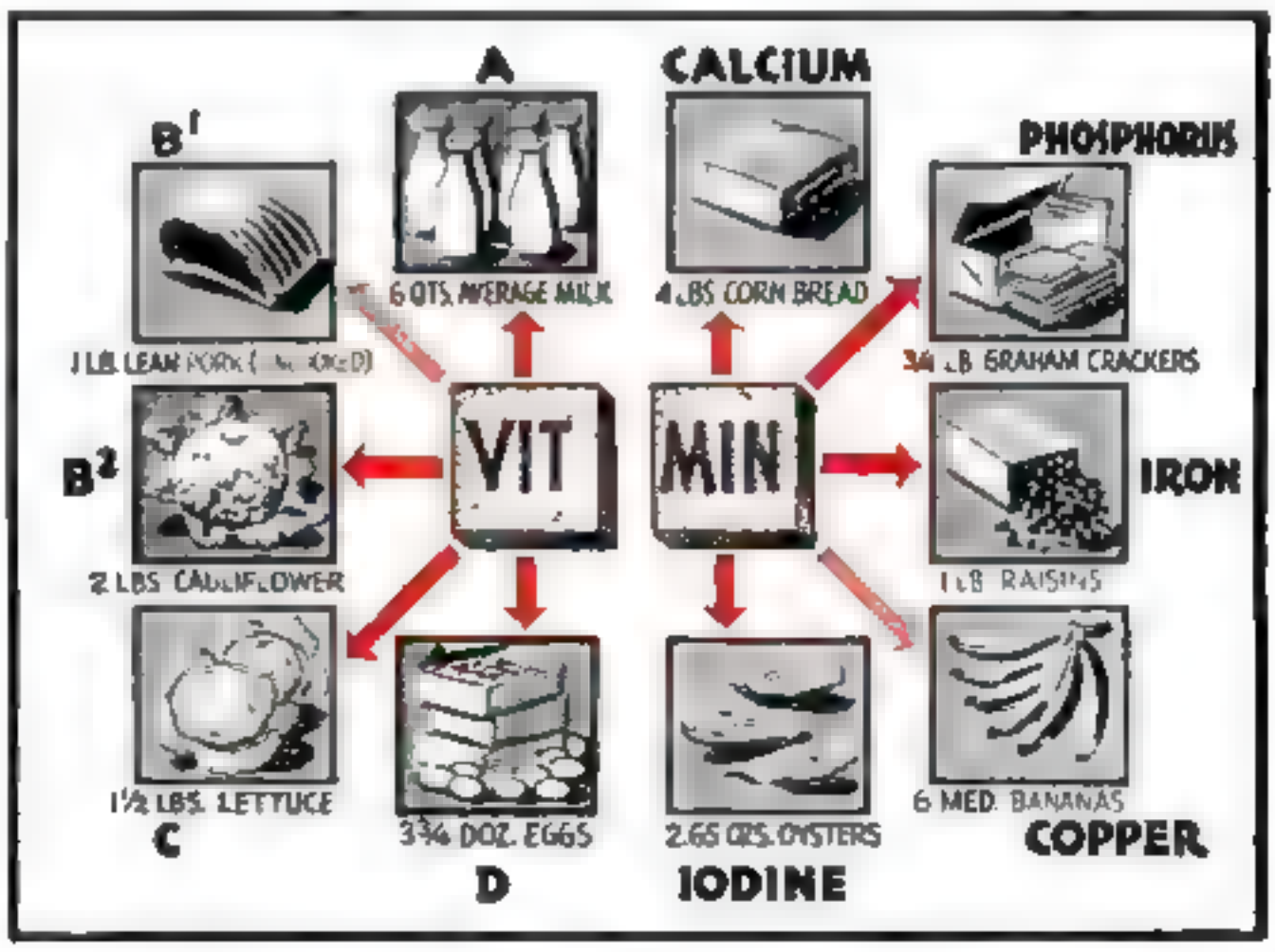
February. In a questionnaire, 88 percent said they benefited by the plan, five percent said they did not, seven percent admitted they did not take enough to know.

The three-month experiment cost—for capsules, cups, and printing—just about $500. Stacking this up against results obtained, Leighton Wilkie decided enthusiastically to gamble once more. This year he is distributing vitamin pills not only to workers in Continental Machines, but to men of the DoAll Company, a subsidiary at Des Plaines, Ill., as well—pills that contain not only A and D, but the whole range of essential vitamins.

According to Dr. T. L. Hazlett, medical director of the Westinghouse Electric and Manufacturing Company, "Vitamin A builds up a person's resistance to infections, and vitamin D helps the body to make better use of calcium and phosphorus. Both are helpful in fighting common respiratory infections which cause so much lost time among workers."

In an effort to prove this statement in wholesale practice, 600 office workers of the Westinghouse Transformer Division, at Sharon, Pa., take chocolate-coated tablets containing vitamins A and D. Three times a day the employees push a button on wall dispensers, and out pops a vitamin pill. Dr. Hazlett is studying the results of the use of these tablets through an entire winter. If they prove their worth, their use may soon extend into the other 26 Westinghouse plants, employing more than 70,000 men and women.

While medical men still debate hotly as to



Quantities of natural foods that would be required to furnish the vitamins and minerals contained in two cakes now being supplied to men at Pratt & Whitney aircraft-engine plant

whether or not vitamin A is of definite help in fighting off infection, they admit unanimously that the vitamin is necessary to good eyesight and vision in dim light. It is especially valuable in the treatment of "glare blindness," the inability to adjust the eyes quickly to sudden darkness or sudden light. Tests made under the direction of Dr. C. W. Brown, at the University of California, indicate that if your diet is deficient in vitamin A for just one day, glare-blindness may result that will increase tremendously your accident hazard in night driving. A day of treatment with vitamin A concentrate may effect a complete cure. Night drivers, civilian and Army flyers who fly at night, now take 30,000-unit doses of vitamin A to minimize the danger from glare blindness and to improve their vision

By improving the workers' eyesight, vitamin A, fed in capsules to inspectors and workers on the assembly line, is now helping produce $3,000,000 worth of binoculars for the Army and Navy, at another large plant doing Government work.

Four years ago this same vitamin was first administered to color matchers at the same plant, whose exacting job was to match enameled stove and refrigerator parts within extremely close color limits. Despite the expertness of these men, about 1.7 percent of stoves and refrigerators were being rejected because of mismatched parts.

Company medical advisers finally became convinced that some of the workers were suffering from eye fatigue not revealed by regular tests. Consultations with medical researchers in clinics and colleges, led to the purchase of a bio-photometer, an instrument which determines whether or not a person is deficient in vitamin A by measuring his degree of glare blindness. Men who were found deficient in this vitamin were given 30,000 units a day, in the form of carotene-in-oil. In a few weeks rejections had diminished 75 percent, an amount which saved the company $8,000 a year.

An important result, in addition to the increased efficiency, was an appreciable improvement in general health. A number of workers reported gains in weight, and others claimed they no longer had fatigue headaches and eyestrain. Several found their eyesight so improved they could discard glasses they had worn from childhood.

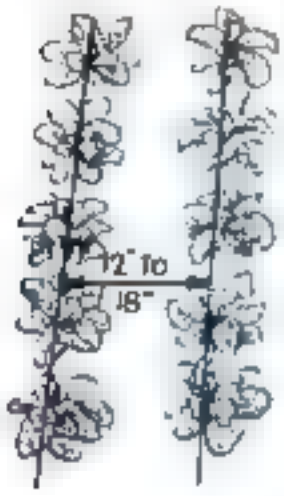
Abundant all-around health—a physical and mental well-being that can stand up solidly under the strain of war and emergency production—rather than fitness for some minor industrial application, is the chief aim of the present drive for vitamins in industry. This is the note sounded by Dr. Victor G. Heiser, who heads the campaign of the National Association of Manufacturers. Single vitamins in big doses, administered under medical supervision, may be useful in the treatment of certain deficiency diseases. Multiple vitamins, however, in optimum amounts, are required for the balanced health of a normal person.

Such multiple-vitamin therapy, involving every vitamin and mineral known to be needed for human nutrition—and measured out, not in traces, but in generous amounts—is now getting its very first large-scale test in this country at one of the big Pratt & Whitney plants manufacturing airplane engines. Foods providing the necessary quantities of minerals and vitamins demanded by this test would have cost from $2.50 to $3.00 a day—and who knows that the men would eat them? Capsules and pills would have been too large—even if they had been available—and would have been too suggestive of medication.

Dr. Howard W. Haggard, professor of physiology at Yale, who is supervising the experiment in collaboration with the Pratt & Whitney medical staff, finally hit on a pair of little chocolate cakes, one packed with nine

Every vitamin and mineral known to be needed in human nutrition is packed into these palatable chocolate-flavored cakes—nine vitamins in the tablet marked "vit," eight minerals in "min"

SPINACH—CULTURE: Stagger plantings ten days apart from early spring until the middle of September. Rows should be 12 to 18 inches apart. Needs lime. Apply nitrate of soda when leaves are forming, again 10 days later. Matures in 30 to 60 days



PREPARATION: Store in a cool, dark place until ready to cook. Wash leaves in cold water without bruising. Shake off part of wash water and cook in a covered pot only 8 or 10 minutes. Add salt, butter. Drink pot liquor, or use in soup

VITAMIN GARDENS

vitamins and the other with eight minerals.

Its makers had anticipated such a need, long ago. For five years, chemists and doctors had been experimenting in Bloomfield, N. J. laboratories, fighting to compound 17 nasty-tasting, elusive chemical materials into two small cakes that could be eaten as palatable food. Some 2,900 combinations were tried. Finally, a few months ago, the desired result was achieved.

Five hundred men have begun the test at Pratt & Whitney. For the first two weeks, three cakes of vitamins and one of minerals were given each man each day, to eliminate quickly any deficiency he might have had From then on, one vitamin and one mineral cake became his daily ration. If health statistics show the noticeable improvement in stamina and efficiency that is expected, 30,000 more men may soon be eating them.

ONIONS—CULTURE: For the average home gardener, onions are best grown from bulbs, or "sets." These are planted in early spring, 12 to the foot in rows about a foot apart. Plant just deeply enough that the tops of sets are at the surface of the ground. When tops are 6 inches high, sprinkle with poultry manure or nitrate of soda, about 4 ounces to 25-foot row

PREPARATION: Young onions may be pulled as desired. When tops begin to die, in late summer, the full-grown onions are pulled and stored in a cool, dry place. If you don't like 'em raw, you lose the least vitamins by boiling them

SNAP BEANS—CULTURE: Plant after danger of frost is over, in rows about 2 feet apart, dropping beans 4 inches apart in the row, and cover with about 2 inches of soil. For a constant supply, plant every two weeks until August. Watch for beetles

PREPARATION: Break off both ends and pull off any strings. To hold vitamins and minerals, cook the beans whole and cut them up after. Cook in boiling salted water to cover, 15 to 30 minutes. Don't use sodium bicarbonate to preserve color

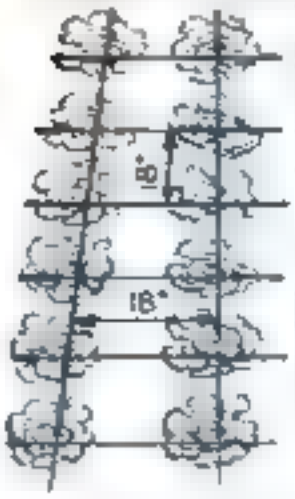
CARROTS—CULTURE: Plant from March until July, in almost any soil. No extra nitrates needed. Put seeds ¼ inch deep in rows 14 inches apart. When seedlings are an inch high, thin to an inch apart. Bright-colored kinds give most vitamin A

PREPARATION: To save vitamins, don't scrape carrots or leave them soaking in water. Eat them raw, or boil them in a little water in a covered pot. Cook just long enough to be tender, not enough to make them mushy, soggy

ARE EASY TO GROW

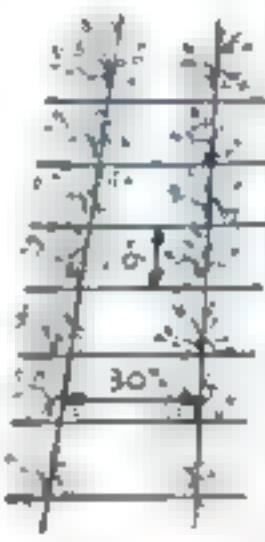
It may sound strange, in this best-fed nation in the world, to speak of widespread hunger that must be fought by drastic changes in diet, artificially enriched foods, and chemical supplements. Yet, at a national nutritional conference called by the President last Spring, the alarming fact was disclosed that 97,000,000, out of the 130,000,000 inhabitants of the United States are suffering from "hidden hungers"—vitamin and mineral deficiencies, often too small to produce recognizable disease, but great enough to keep men and women "under the weather," nervous, low in energy, susceptible to colds, poor in muscle and morale.

It is to satisfy these hidden hungers, which are almost as common among the well-to-do as among the poor, that vitamins are being enlisted to safeguard health and vitality for the nation's supreme effort.



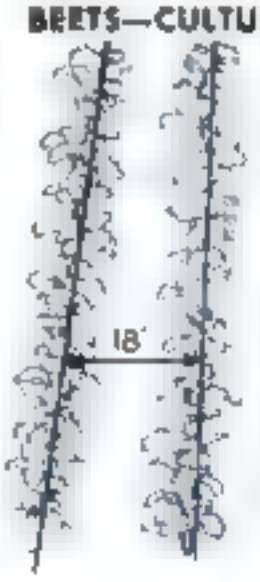
LETTUCE—CULTURE: May be raised from plants bought in the spring, or from seeds. Choose loose-leafed, deeply colored varieties. Plant seeds ½ inch deep. Thin seedlings to 4 inches apart; later, thin plants to 18 inches apart in all directions

PREPARATION: Do not throw away outer, greener leaves, which contain most vitamin A. Wash in cold water but do not bruise, as vitamins and minerals will bleed out. Use as soon after picking as possible, to get the precious vitamin C



POTATOES—CULTURE: Plant only certified seed potatoes, cutting them so there are at least two good eyes in each piece. Plant in April, 5 inches deep in drills about 30 inches between rows and 9 inches between the pieces of potato. Fertilizer should be worked into the soil before the pieces are planted. Dust or spray the vines with a poison to control bugs

PREPARATION To keep the vitamins, potatoes should be either baked or boiled with their skins on. Frying lowers the vitamin content considerably. When in storage they lose much of their vitamin C, but retain much B-1, B-2, minerals

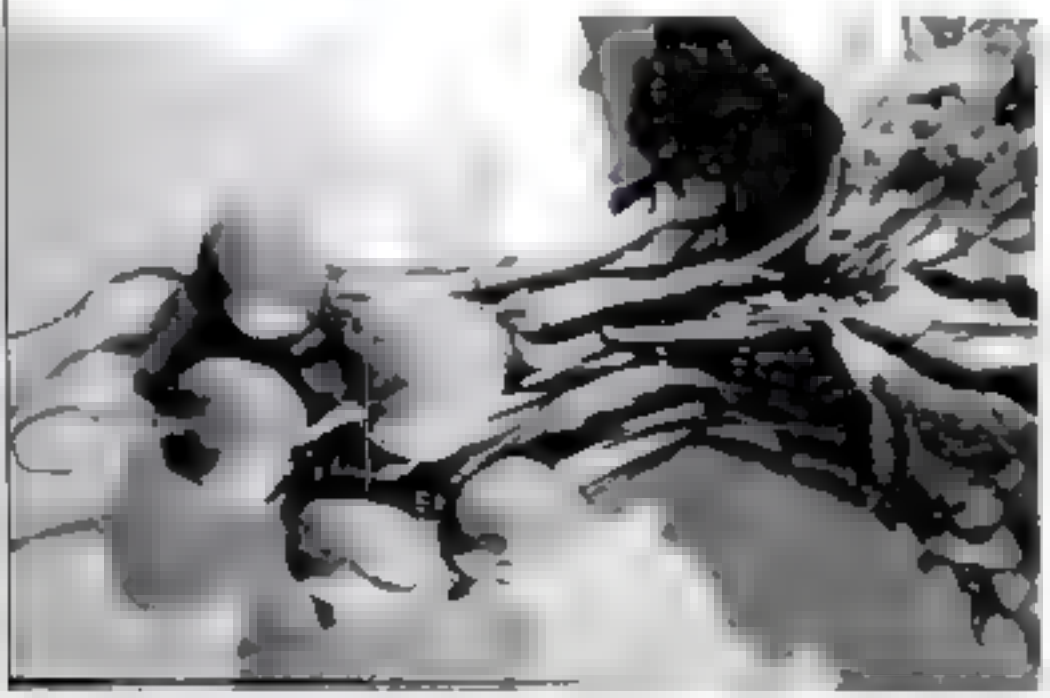


BEETS—CULTURE: Sow early, then every two weeks until August. Place seeds about ½ inch deep, in rows about 18 inches apart, and press soil down firmly. When tops are 5 or 6 inches tall, apply a little nitrate of soda, thin to 4 plants a foot

PREPARATION: Use as soon as possible after pulling. Wash thoroughly and boil in salted water 30 to 60 minutes. When tender, plunge them in cold water and rub off the skins. Tops may be cooked separately for use as greens

TOMATOES—CULTURE: Buy plants from a local nursery and set out in rows 3 to 4 feet apart, 12 to 15 inches between plants in the row. No extra fertilizing is needed. Early-set plants can be protected from cutworms by the use of a poison bran mash

PREPARATION: To get every vitamin that a tomato contains, you should eat it fully ripe, freshly picked, and raw. If you like them cooked, baking destroys less vitamins than stewing. But even stewed tomatoes have worthwhile supply



A Home Guard company commander with a mortar made from a piece of metal piping or castoff boiler tube

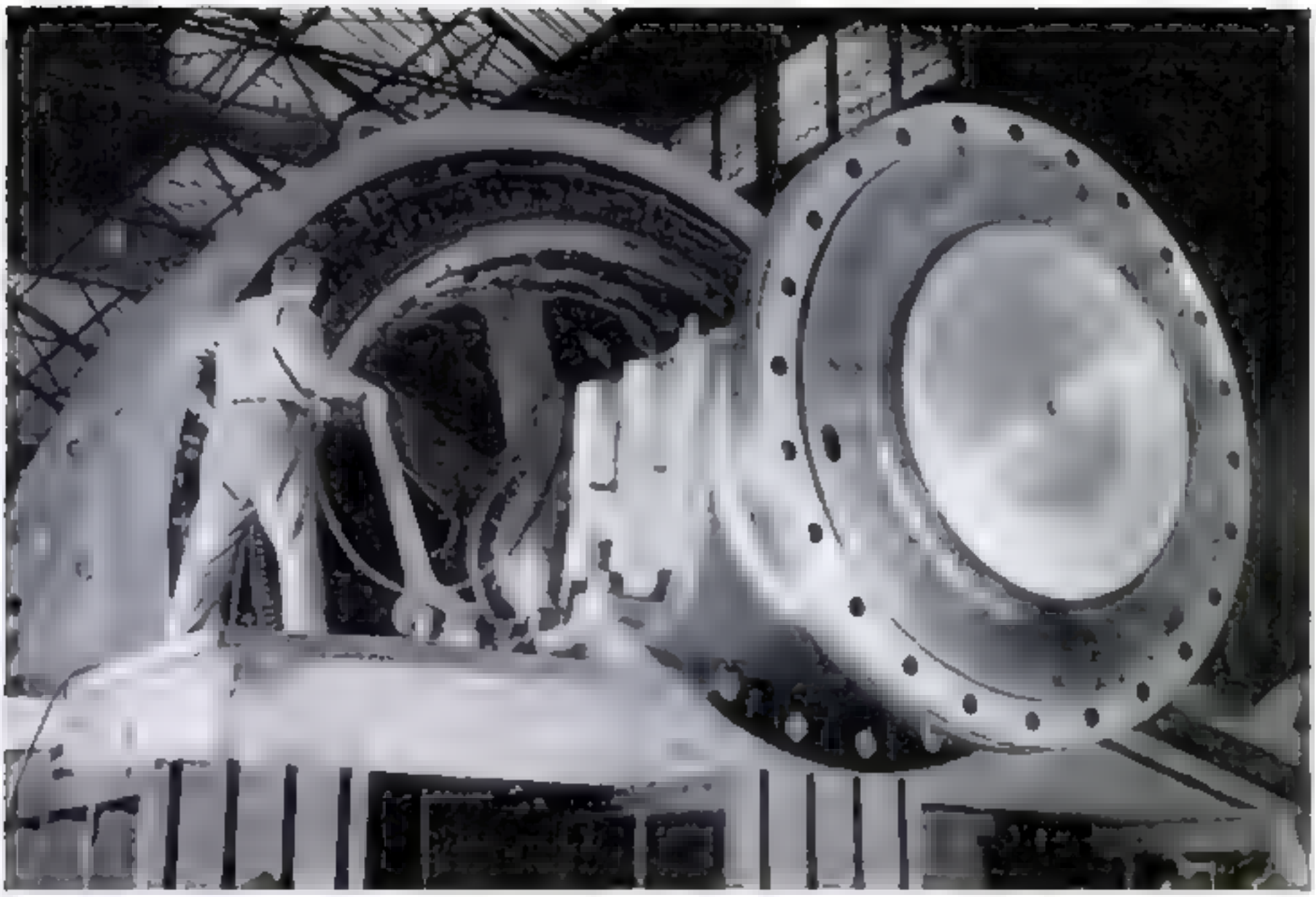
Setting the mortar for action. A quick jab in the ground with the spadelike tail holds it in position

The bomb fuse is lighted by tipping a lighted match to its end. This job needs steady nerves and hands

BRITISH HOME GUARDS MAKE THEIR OWN MORTARS

OUT of scrap materials British Home Guardsmen are making their own mortars which can lob six-pound explosive or smoke shells as far as 350 yards with a remarkable degree of accuracy. The four-inch barrels of these homemade weapons consist of old pieces of metal piping or boiler tubes. Instead of a tripod base, used on regulation mortars, the Home Guard weapon has a tail in the form of a spade which is shoved into the ground and holds the mortar in position at the desired angle of fire. A fuse on the shell is lighted, the shell is dropped into the barrel, and the explosion hurls the projectile at the target. The weapon can be used to blast enemy vehicles or parachutists, and is expected to give a good account of itself in the event of an invasion attempt. The cost of the entire device is less than ten dollars.

Dropping the charge in the barrel. Within four seconds after the fuse is lighted, the shell is fired. The four-inch weapon lobs a six-pound projectile 350 yards with remarkable accuracy

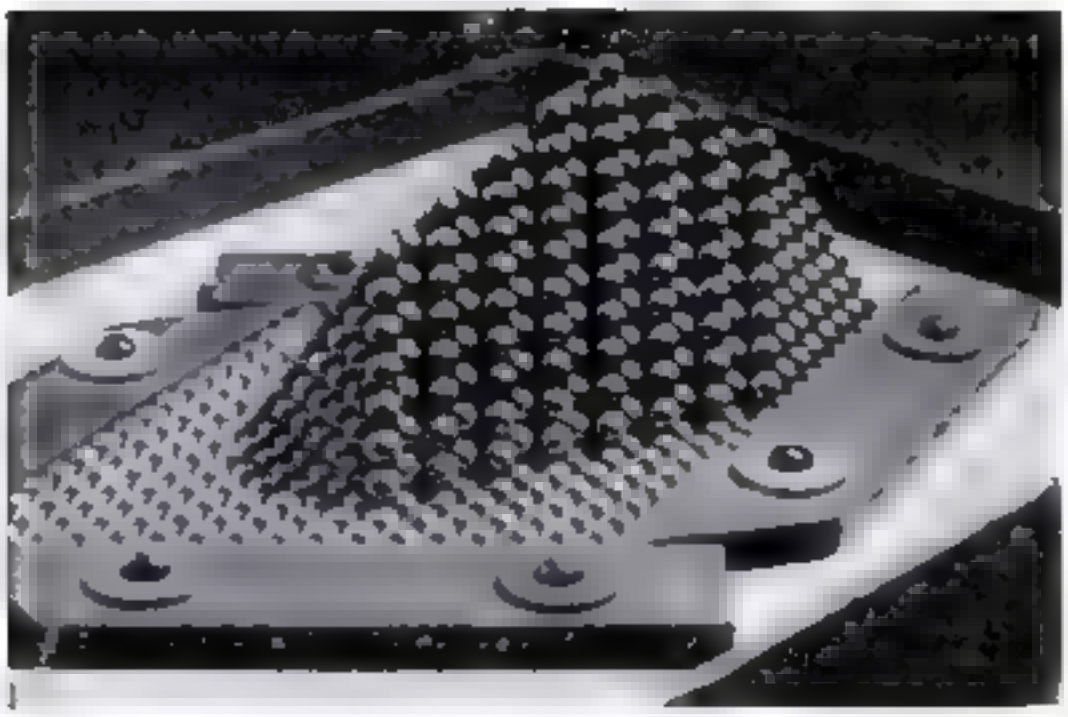


Testing a 5,000-horsepower motor that will help produce metal for fighting planes in a great new sheet mill

MORE PLANES MEAN MORE ALUMINUM

New Plants and Processes Swing into Action to Meet the Demand for This Essential Material of Air Power

By ALDEN P. ARMAGNAC



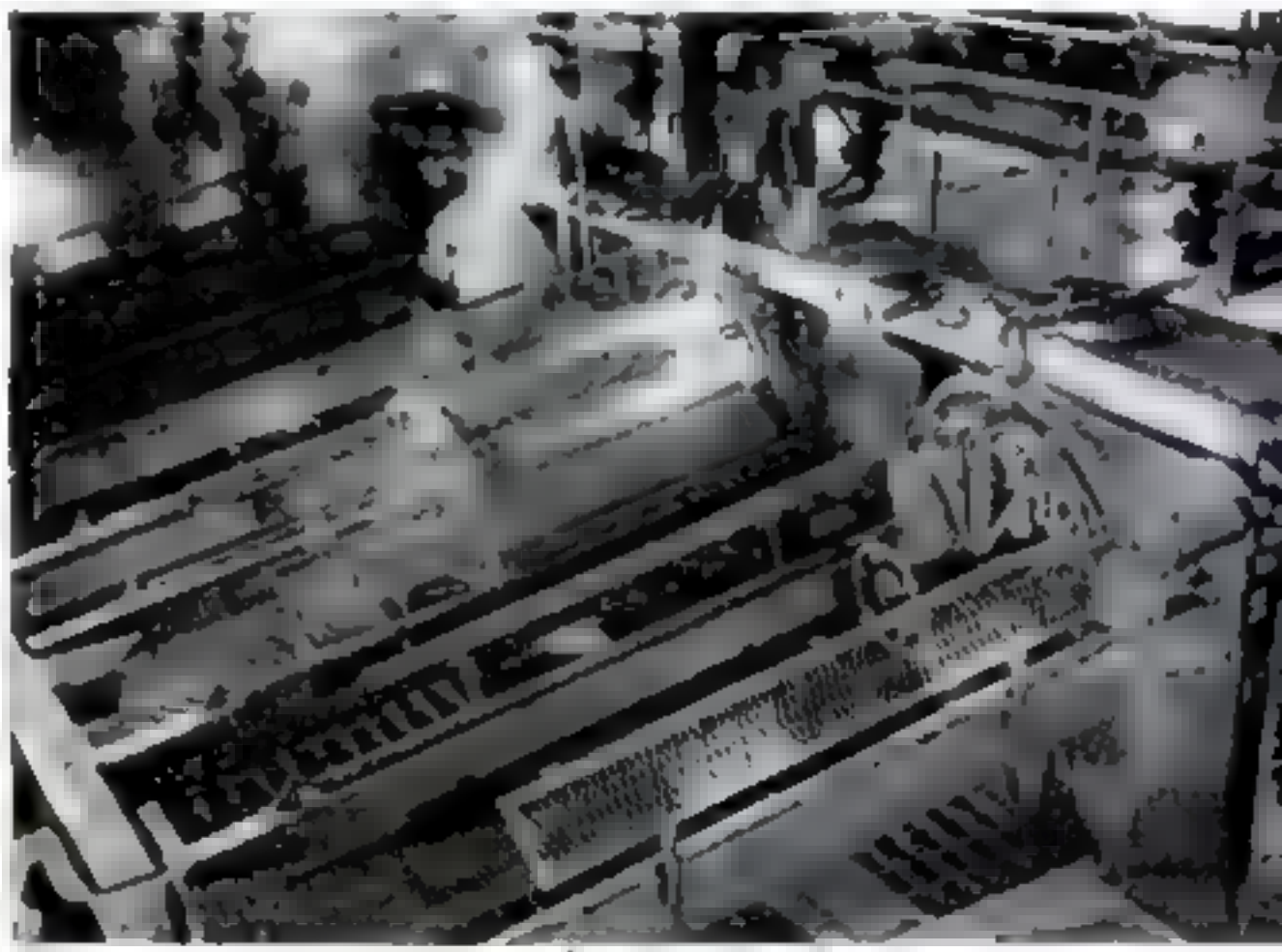
Atomic model of aluminum, with steel balls representing atoms magnified about 20,000,000 times. Their arrangement indicates "face-centered cubic crystals"

SIXTY THOUSAND new airplanes in 1942. One hundred and twenty-five thousand more planes in 1943. These stupendous figures must be met by the American aviation industry, the President declares, in our all-out war effort.

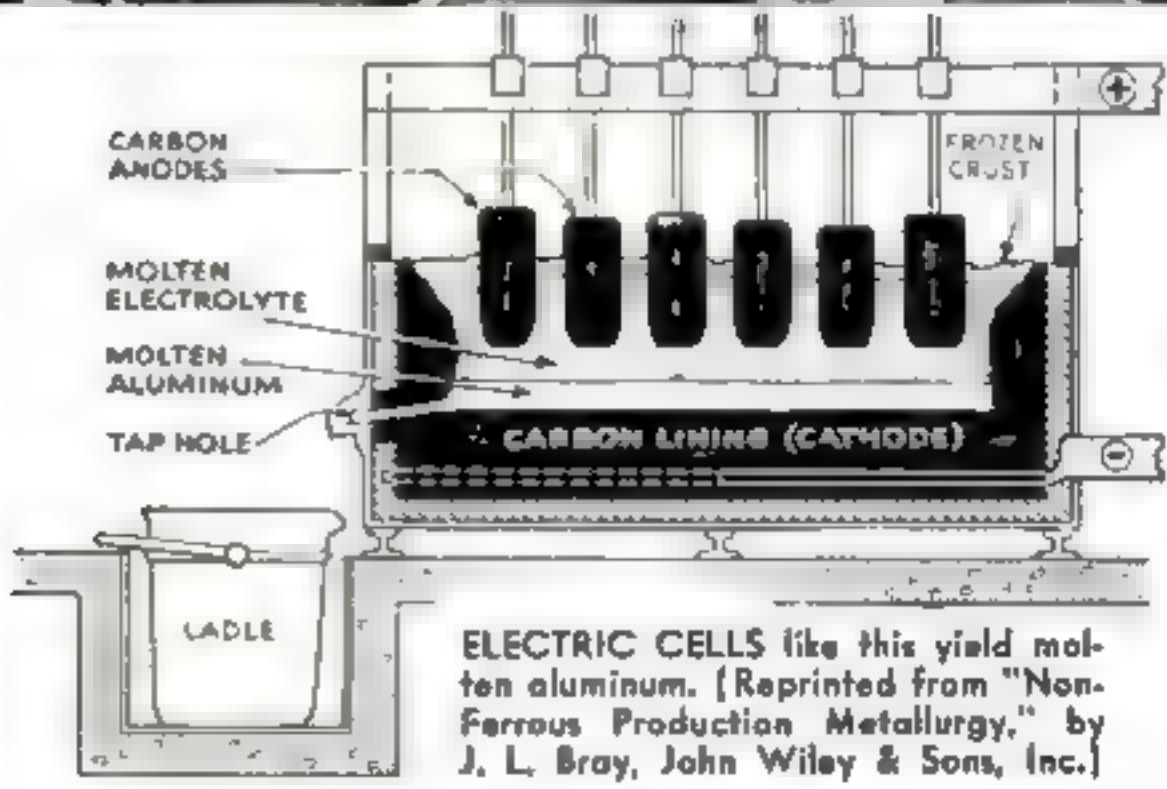
And about nine tenths of the weight of a modern plane consists of aluminum. That simple fact explains why United States troops moved into Dutch Guiana, in South America, to guard the nearest nondomestic source of bauxite, claylike ore of aluminum. It accounts for door-to-door collections of aluminum articles including pots and pans, hat forms, slot machines, racing horseshoes, practice violins, tap-dancing

Underground mining of bauxite, the ore of aluminum. If the ore is deep in the ground, it is mined much like coal, as shown. But if it is near the surface, it is removed by open-pit methods. Overlying sand and dirt is scraped off and the surface of bauxite cleaned, after which the ore can be loosened in the bed by dynamiting and loaded in mine cars

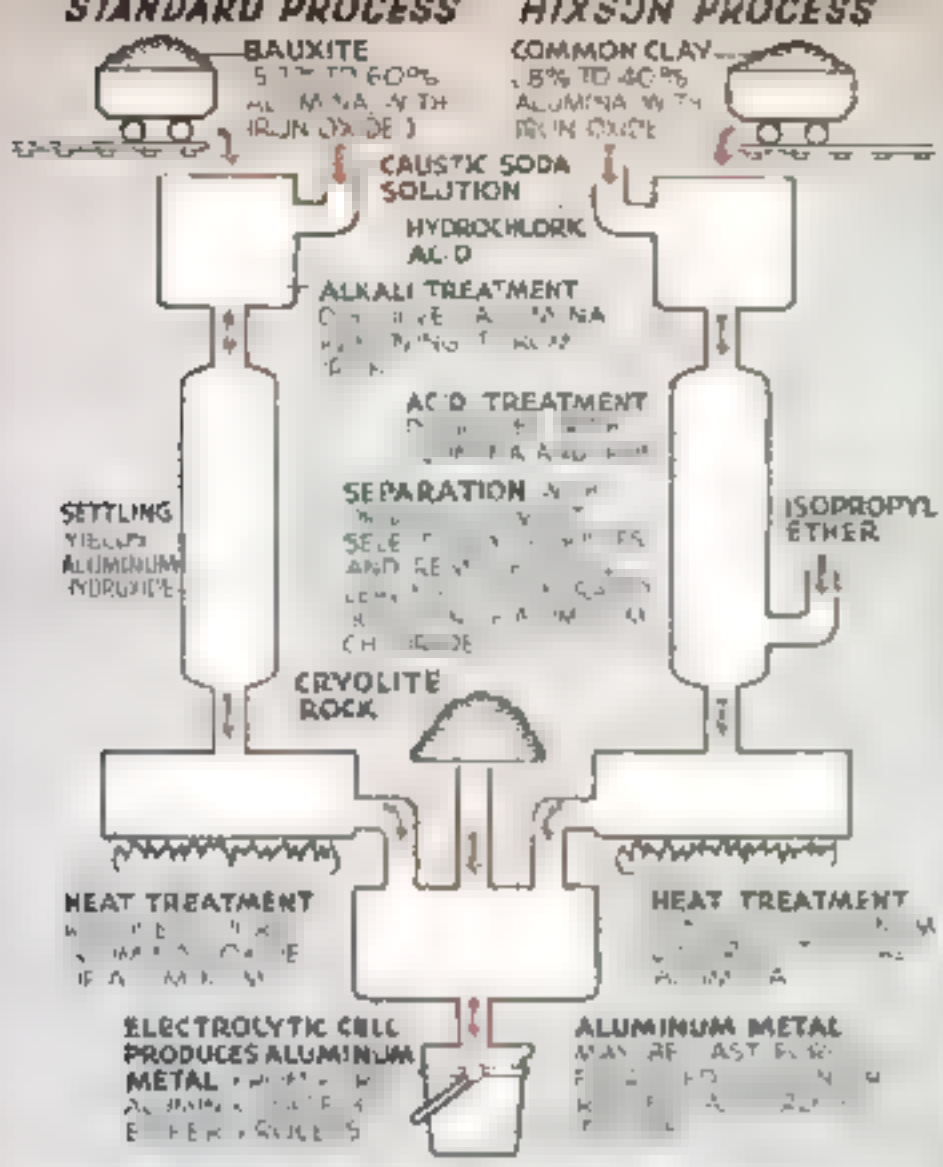
Crushed, dried, and ground to a powder, ore is digested in a hot solution of caustic soda which dissolves the alumina, or aluminum oxide. Impurities are removed by these large filter presses . . .



. . . while the solution containing the aluminum is pumped into tall settling tanks. As it cools, aluminum hydroxide is precipitated. When this is heated in rotating kilns, the alumina is obtained



ELECTRIC CELLS like this yield molten aluminum. (Reprinted from "Non-Ferrous Production Metallurgy," by J. L. Bray, John Wiley & Sons, Inc.)



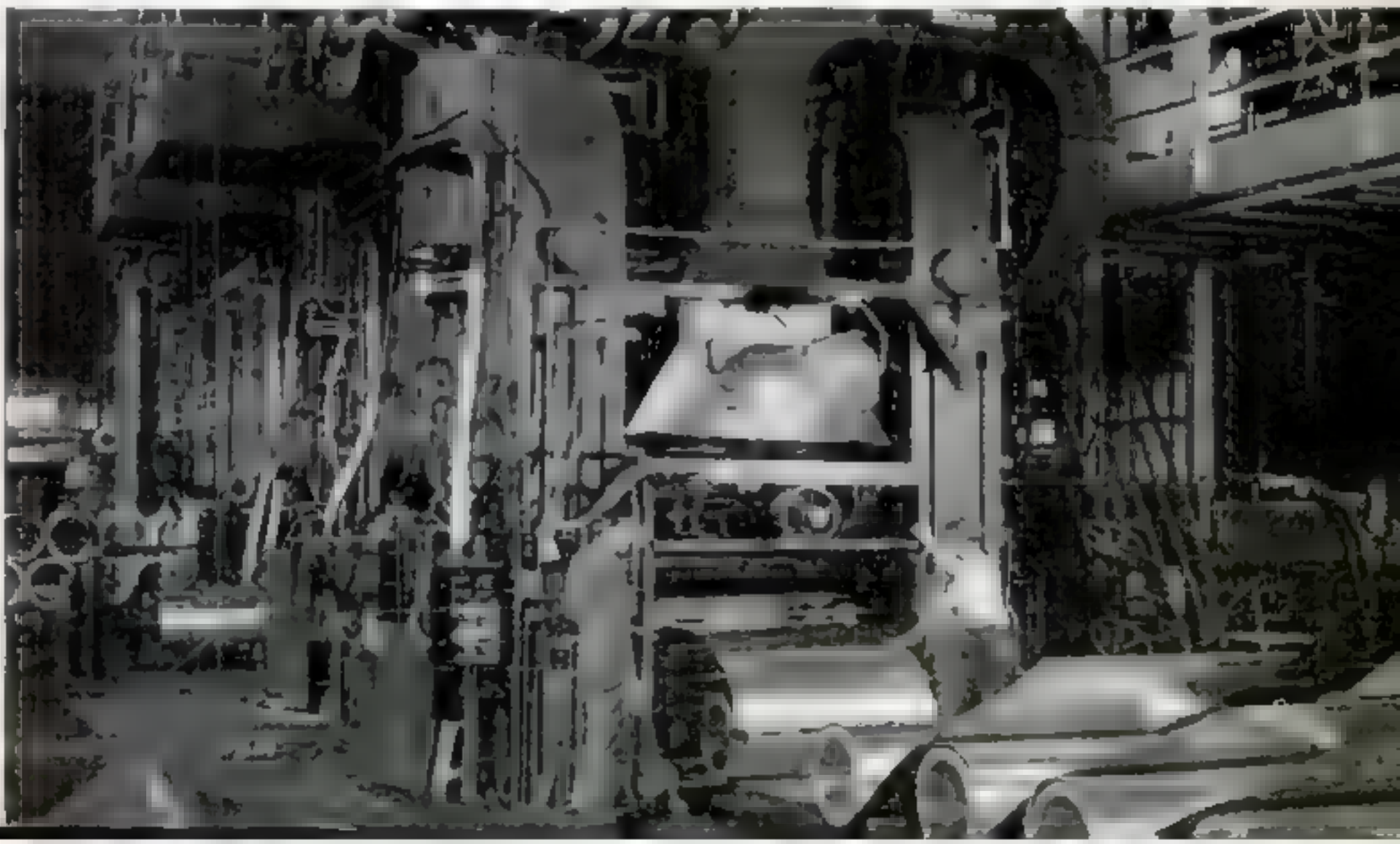
This simplified "flow sheet" compares the major steps in producing aluminum from bauxite (standard process) and from common clay (new Hixson process)

Molten aluminum pours from a giant ladle into molds to form pigs of the pure metal. It may be forged cast or rolled into various parts for warplanes

dogs, and even a bas-relief of Adolf Hitler. And it lies behind stringent restrictions of nonessential consumption of aluminum, not only for civilian but also for military uses such as mess kits, in which stainless steel and plastics replace the "airplane metal."

Plane makers say that they can turn out their quota of aircraft if they can get the aluminum to do it. By far their biggest need is sheet aluminum, to cover wings and fuselages. To help existing plants meet it, the largest aluminum-sheet rolling mill in

Rolling aluminum sheet for covering wings and fuselages. It also is used extensively for forming aircraft structural members. About nine tenths of the weight of a modern plane consists of aluminum of all kinds



Forging a strong aluminum-alloy propeller blade. This is the first step in the production of an aircraft propeller. From the forging plant the blade goes to the manufacturer for machining, balancing

the world is swinging into action. Erected by the Aluminum Company of America, it will turn out enough high-strength sheet metal to provide for 1,000 medium bombers a month.

Aluminum "pigs" entering the 58-acre building will emerge as the finished product four tenths of a mile away. Electric motors of 5,000 horsepower drive the mill that flattens the ingots into slabs, which then pass continuously through a series of rolls. Each roll reduces the thickness and increases the length of the sheet, until it is ready to be sheared to size for shipping. Intensive research has made it possible to use ingots of exceptional size, and to reduce the number of rolling operations, so that the sheet comes out of the rolls 50 times faster than ever before.

Other mills, scattered country-wide, forge aluminum into parts like airplane propellers; cast it in sand molds, for cylinder heads and a variety of fittings; roll aluminum rod or bar for structural fittings; and draw aluminum tubing for framework and for fuel and oil supply lines.

First, however, comes the difficult task of winning the lightweight metal from its ore. One of nature's ironies makes aluminum, easily the most abundant of all metals in the earth's crust, one of the hardest to extract. Every ton of aluminum produced means the expenditure of bauxite, soda, lime, cryolite, coke, tar, and pitch totaling nine tons, 22,000 cubic feet of gas fuel, or the equivalent in coal, and enough electricity to supply the average home for 35 years!

Bauxite, the principal raw material, comes from Arkansas, Alabama, and a few other southern states; and from Dutch Guiana. If it is found near the surface, open-pit mining recovers it. First, any overlying sand or earth is removed, and the surface of the bauxite carefully cleaned. Then the ore is blasted loose with dynamite and loaded into mine cars. In case the bauxite lies deep below the surface, it is mined, much like coal, by underground tunneling.

High-grade bauxite contains up to 60 percent of alumina, the oxide of aluminum, which serves as the starting point for producing the metal itself. But the ore also includes a troublesome percentage of iron oxide and other impurities, which first must be eliminated. Therefore the ore is hauled from the mines to a near-by mill where it is crushed, washed to remove intermixed clay, and dried in rotating kilns. Ground to powder, it is treated with a hot solution of caustic soda, or lye. This dissolves the alumina, but the impurities are left behind as red mud when the solution is filtered.

Now the solution is pumped to precipitating or settling tanks as high as a five- or six-story building. As it stands and cools, a sandy white substance called aluminum hydroxide settles to the bottom. This is nothing more than alumina combined with water. To drive off the water, the product is heated white-hot in long rotating kilns, and snow-white alumina remains.

Some of it is sold in this form as an abrasive—and also, fused and cast into blocks, as a refractory material for withstanding

great heat. In fact, alumina ranks as one of the stubbornest of the common metallic oxides to decompose. The trick of extracting aluminum metal from it was the epochal discovery of C. M. Hall, a 22-year-old amateur chemist of Oberlin, Ohio, in 1886. He succeeded in taking alumina apart by passing electric current through a solution.

Today this is done in shallow, elongated electrolytic cells filled with molten cryolite, or "ice rock," in which alumina dissolves. Natural cryolite, a translucent white mineral, is found at only one place in the world —Ivigtut, Greenland. To offset any conceivable interruption of the supply, however, chemists have developed synthetic fluoride salts of similar composition.

Carbon anodes, formed from petroleum coke, tar, and pitch, dip into the electrolytic bath. A thick lining of carbon within the heavy steel pot forms the cathode. Thousands of amperes of electric current, flowing between these electrodes, heat the bath and keep it molten. Moreover, the electricity breaks down the dissolved alumina, and metallic aluminum collects in a pool at the bottom. As many as 100 of these cells may be used in a single installation.

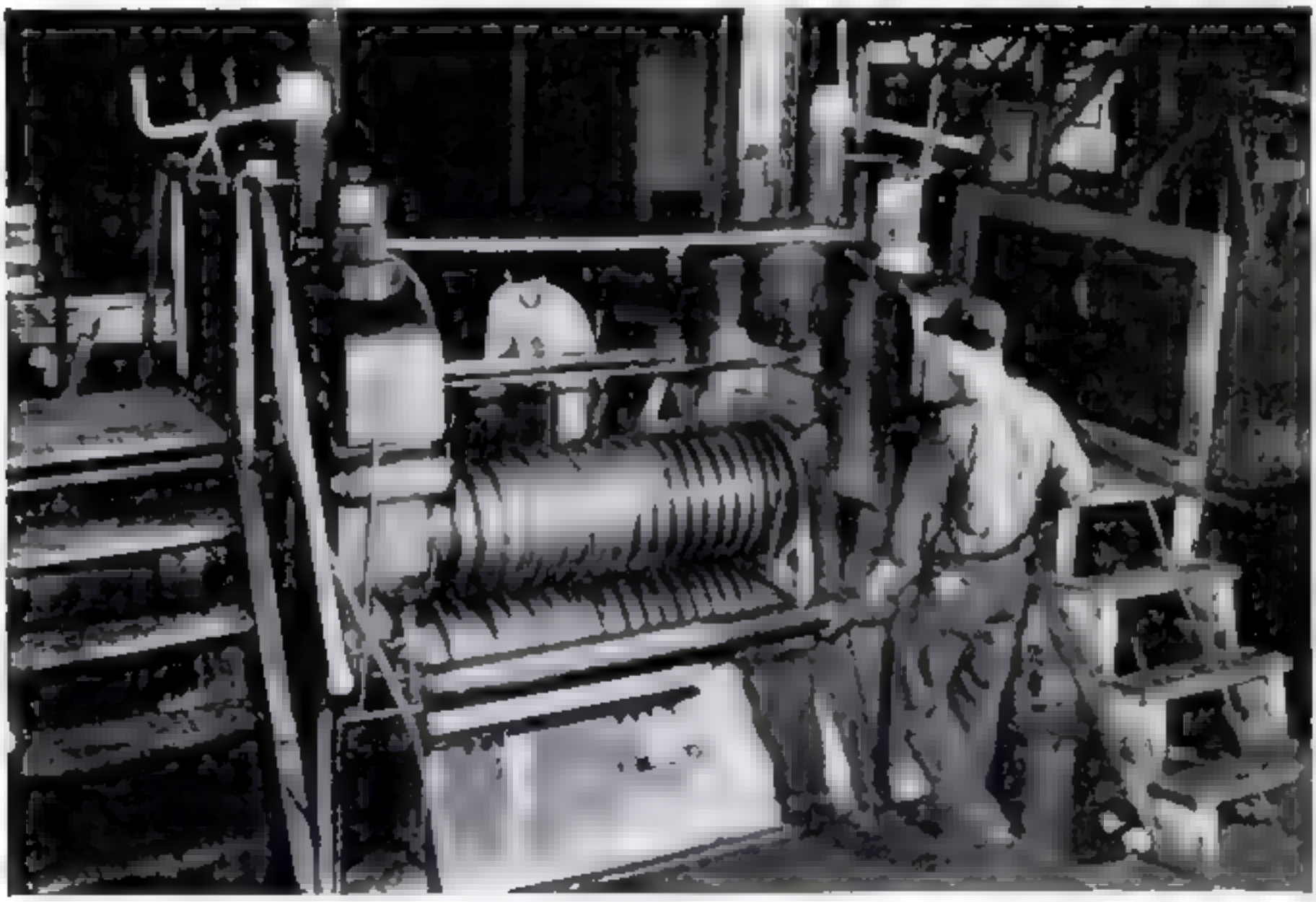
Until now, bauxite has been the only ore of aluminum. But many an official brow has furrowed at rising consumption. Under the enormous demands of war production, it was feared, known bauxite deposits in the United States would soon be exhausted.

Fortunately that prospect has been foreseen by Prof. Arthur W. Hixson, Columbia University chemical engineer. His answer is a remarkable new process to extract aluminum from plentiful, common clay, and from low-grade bauxite. For the first time, he says, it employs an organic solvent to solve a metallurgical problem.

First he uses boiling hydrochloric acid on roasted clay, dissolving both the low alumina content and the iron impurities. Then he adds isopropyl ether, a by-product of isopropyl alcohol, which is used in the manufacture of acetone. The organic liquid selectively dissolves the iron, but not the aluminum. Forming a separate layer because of its different specific gravity, it may readily be drawn off, leaving a concentrated solution of aluminum chloride. The latter, when heated, yields pure alumina, which is treated as in the standard process.

Best of all, this economical process may be put into immediate, full-scale operation whenever need arises. No experimental "pilot plant" will be required to work out production problems, according to Professor Hixson, because each separate step already is familiar to the chemical industry. Perhaps here is the means of creating and maintaining our future air armadas.

Aluminum rod or bar is rolled by machines like this. In addition to its use for airplane structural fittings, this form of the lightweight metal is employed in making many types of screw-machine products

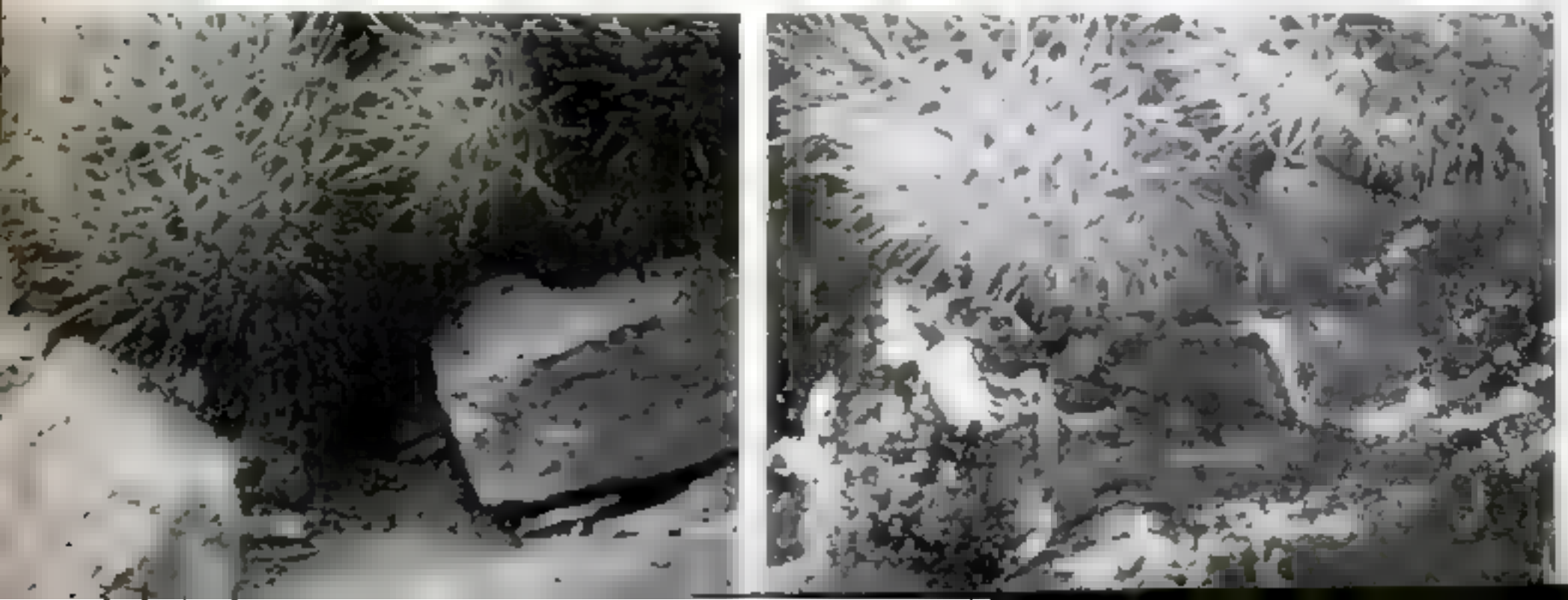


HUNTING TUNGSTEN WITH BLACK LIGHT

Black light prospectors at work in an abandoned gold mine tunnel. In inset examining sand under ultraviolet light for scheelite, ore containing tungsten needed for defense

PLODDING about at night with mercury-vapor lamps casting a dim ultraviolet light, modern prospectors are tracking down elusive scheelite, ore of tungsten. When it strikes scheelite, the ultraviolet light makes the ore fluoresce and what appears like ordinary rock in the daytime shines in the darkness with a deep-blue radiance. Supplies of the important war material have been found in western deserts, in abandoned and active mines. In one big gold mine near Nevada City, an ultraviolet torch disclosed a rich streak of tungsten beside a vein of gold and the mine's owner was astonished to find that rock thrown away in the dumps was "lousy with the stuff." Black-light prospecting is said to open vast new sources of tungsten

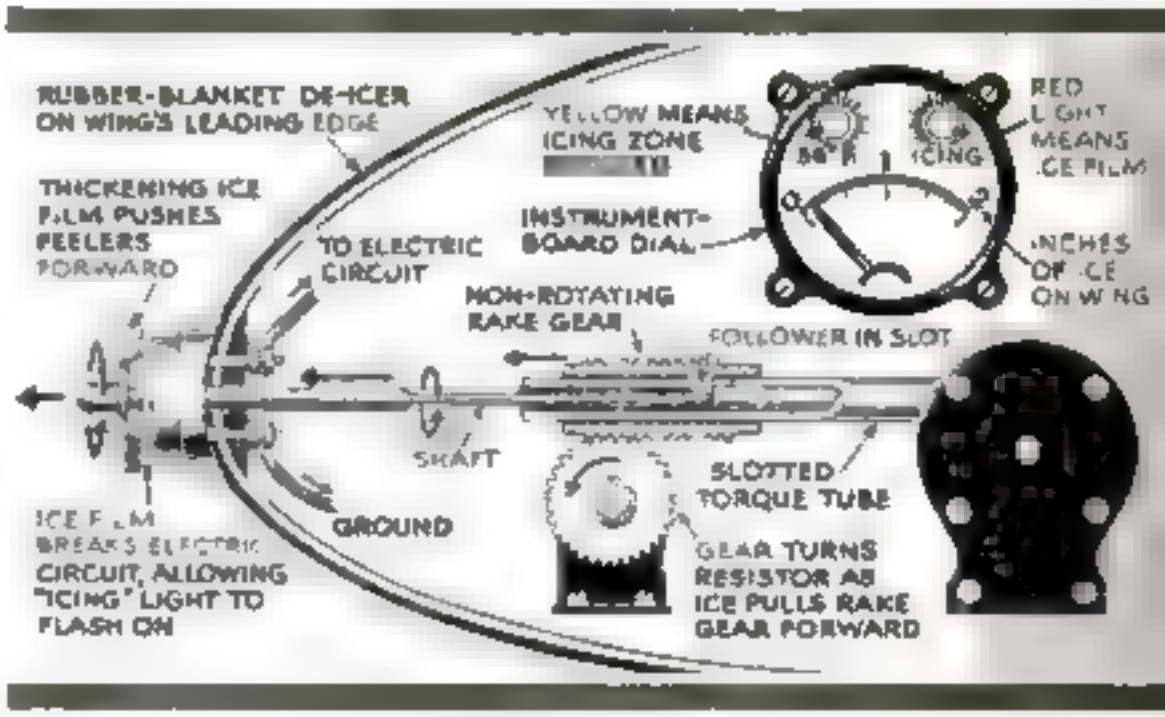
Rock containing scheelite as seen by daylight (at left below) and under the filtered rays of a mercury-vapor lamp. Ultraviolet light striking the valuable mineral makes it glow in the dark with blue radiance



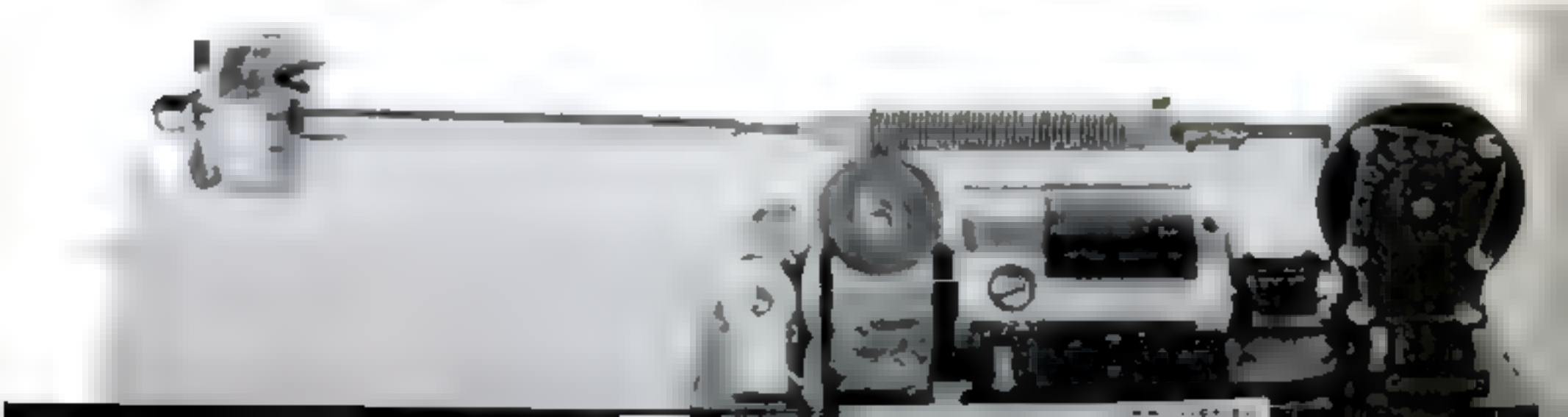
On this laboratory plane wing's leading edge, ice has lifted the turning "feeler" off its seat, breaking a contact to turn on a warning light. Feeler turns slowly to prevent slinging off water and allow ice to form

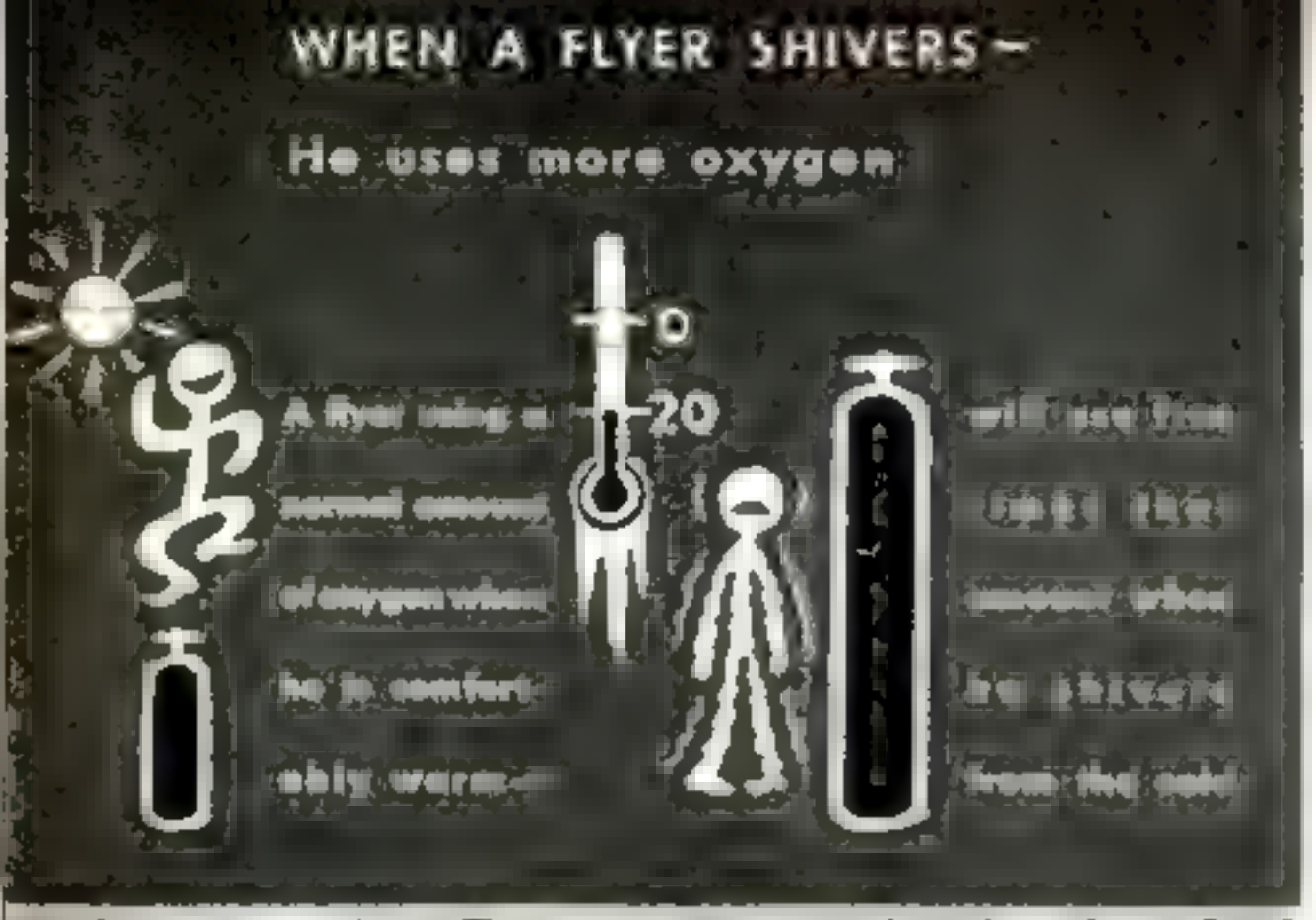
Ice Detector on Plane Wing Warns Pilot To Use De-Icer; Measures Coating Thickness

ICE formation on the wings of planes during flight may now be detected and measured by a device set into the leading edge of a wing. Invented by John F. Carssow, of Los Angeles, and tested in operation on a Western Air Lines plane during the winter, it instantly tells a pilot when to turn on the plane's de-icing equipment. A propellerlike feeler in front of a tiny pillbox-shaped housing on the leading edge is turned slowly by a motor when outside air temperature drops to 36 degrees, and a light simultaneously flashes on the instrument dial to warn the pilot. The first thin film of ice on the pillbox forces the feeler forward to break an electric contact. This operates a relay switch to close a second circuit and light a second warning light. Movement of the feeler forward as the ice builds up also moves part of its telescoping drive shaft which thus operates a variable resistor in the second circuit. As the resistance changes, a hand moves accordingly on the dial which is calibrated to show the build-up of the ice in quarter inches from ¼ to two inches. Operation of the device can be made automatic, turning on the de-icer at a given depth of ice.



Right, note feeler's drive shaft that telescopes outward as ice forms. A rake gear on the shaft moves a variable resistor, altering current flow in the gauge which is calibrated to record ice thickness in inches. Below, complete unit for an airplane wing





How

AIR SURGEONS

IF ANY "secret weapon" is to prove important in the present war, it is just as likely to be an instrument of life preservation as of death dealing

In aviation this is particularly true. If this nation's bombardiers can learn to operate as efficiently as their engines at deathly high altitudes, if its pursuit pilots can learn to stand a centrifugal force of nine or ten gravities instead of only five or six G's as they maneuver to strike the enemy, if its night fighters can learn to see in the dark, then such accomplishments may well be decisive in obtaining air superiority.

The new frontiers of velocity, altitude, and night vision are crucial battlegrounds, and on them leadership falls on the medical branch of the U. S. Army Air Forces—the flight surgeons. Today impressive financial and brain resources from leading research institutions have been enlisted, but the fact that America is not lagging on these frontiers is due to the devotion of a few

AT TWENTY BELOW ZERO in the Army's new refrigerated test chamber, a flyer shivers in ordinary clothing while taking the "Douglas bag test" to show how cold increases oxygen consumption. The chamber can be brought to 67 below to match conditions in the substratosphere. At right, the warmly clad observer carries bag containing exhaled air out of the chamber

Flyers Are Redesigned

GROOM MEN FOR SURVIVAL AT HIGH ALTITUDES

flight surgeons who faced down a myriad of discouragements and stuck to their research during the starvation years of military aviation.

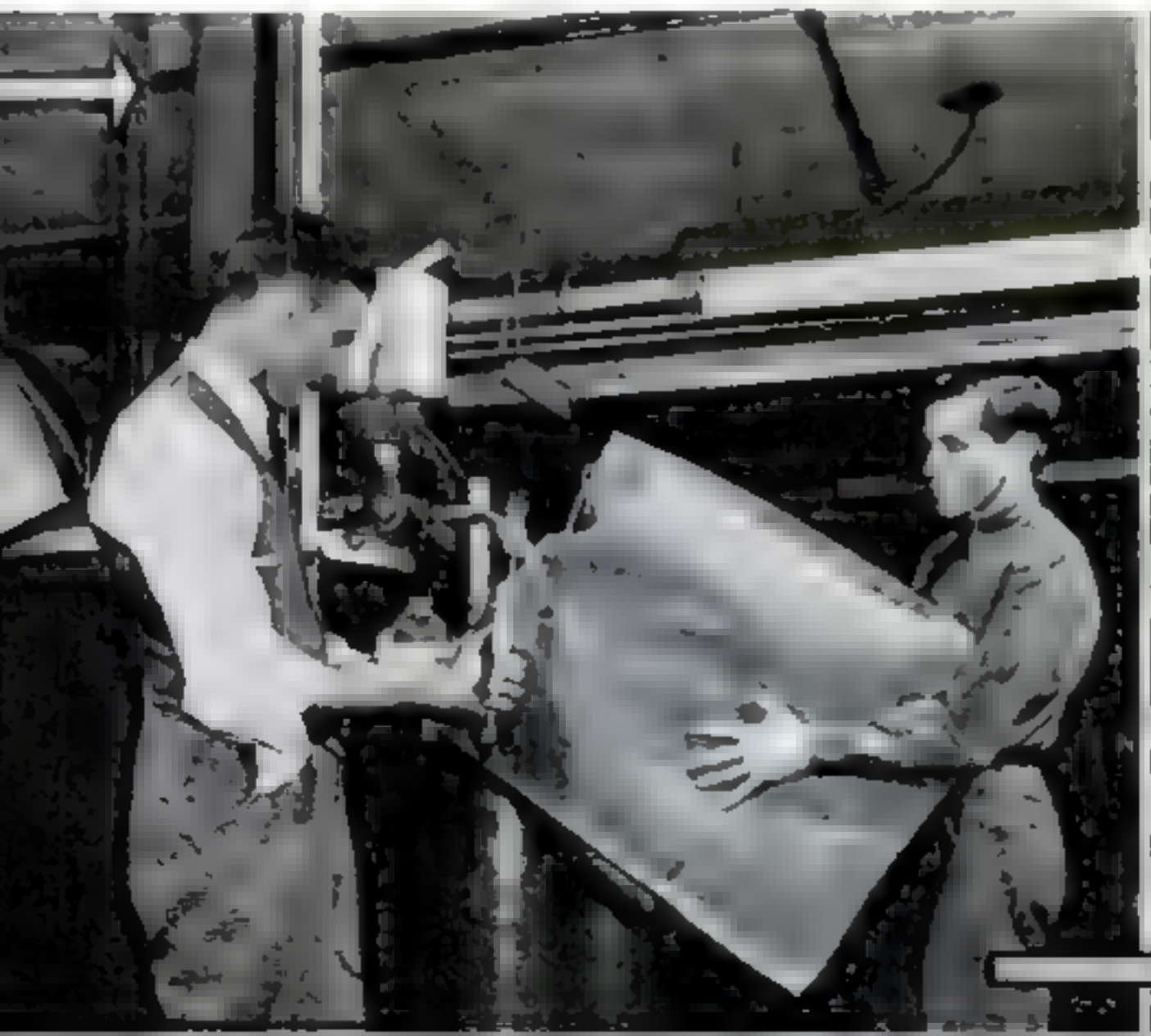
There is an unearthly, mechanistic, man-from-Mars quality about this whole subject of man's adaptation to an unnatural element, which makes it difficult to keep in mind that it all comes down to the aches and pains, the homely frailties, of the individual. But the flight surgeon never forgets it. The flight surgeons for years have maintained their research laboratory at Wright Field, Ohio, and now have established several new research laboratories at various Air Force Stations. Through these funnel all the findings of the various research organizations now working on the physiology of flight. But as the service is administered by the Air Surgeon, Col. David N. W. Grant, their work all comes down to the individual physician who lives with each air squadron, practicing preventive medicine as a sort of combination family doctor and athletic trainer, watching the pilots physically, mentally, and emotionally, keeping them fit to function in an element for which nature never intended them.

The newest and most mysterious job of the flight surgeons is the problem of night vision. The coming of actual war in 1939 changed night military aviation immediately. The blackout was something new to mankind. Pilots had to learn to land without floodlights, only a few faint clews. They had to learn to distinguish the enemy as only a dim silhouette in the dark sky. Their glareless instrument board, worked out with infinite care by the flight surgeons and engineers, had to be darkened along with everything else.

It soon developed that pilots with perfect day vision showed wide variations in ability to see at night. Strenuous efforts still are being made to perfect simple, speedy tests to pick the best night fighters.

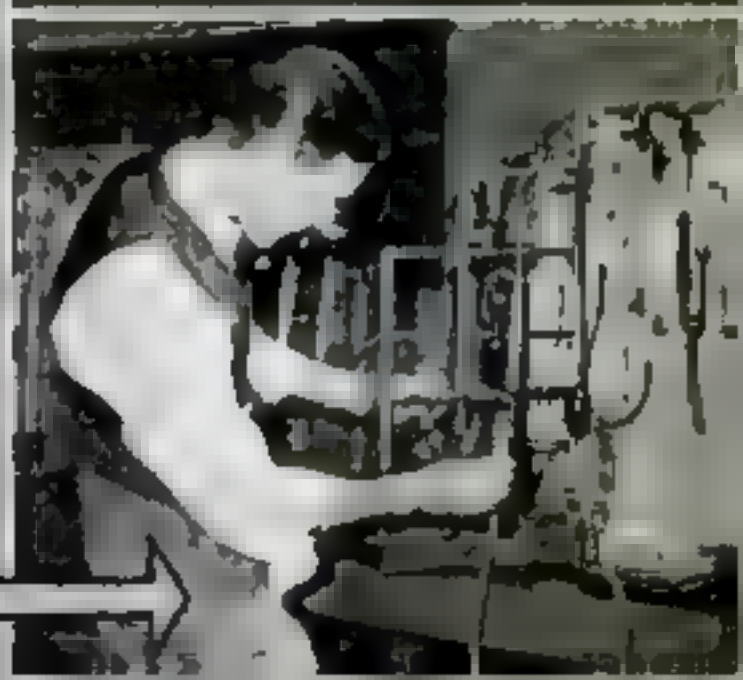
The photochemistry of night vision is still mysterious, but it is thought to be intimately connected with vitamin A in the diet. A deficiency of vitamin A causes xeropthalmia, an eye inflammation commonly associated with night blindness; but the Air Forces are interested in something much less obvious than that.

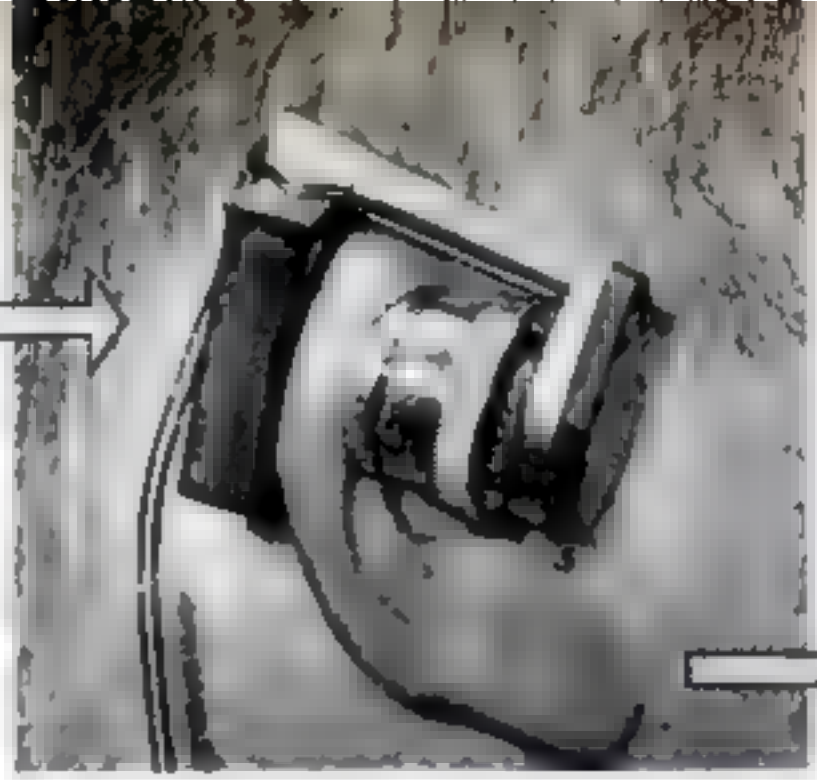
In the retina of the eye is a pigment known as visual purple, very sensitive to dim light, formed by a combination of vitamin A with certain proteins. Light bleaches out the visual purple in the eye. Prevailing theory is that adaptation to darkness depends on the amount of visual purple stored up in the eye, and that glare blinds us by bleaching it out. Blindness follows glare until the pigment is restored. Whether or



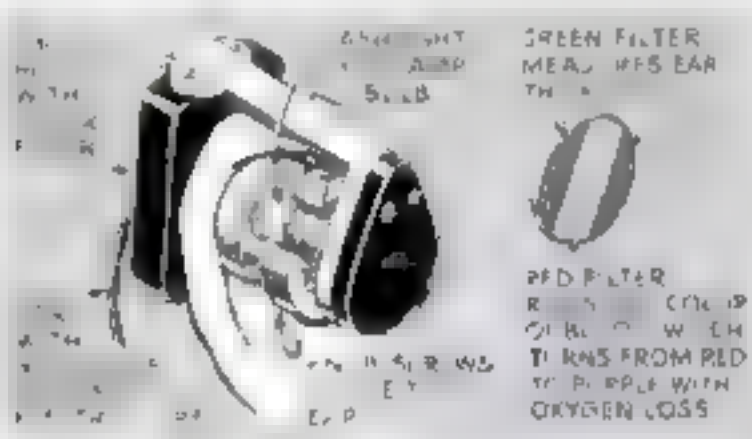
EXHALED AIR is measured by forcing the contents of the bag into a telescoping tank called a spirometer, while a small sample is drawn off for analysis.

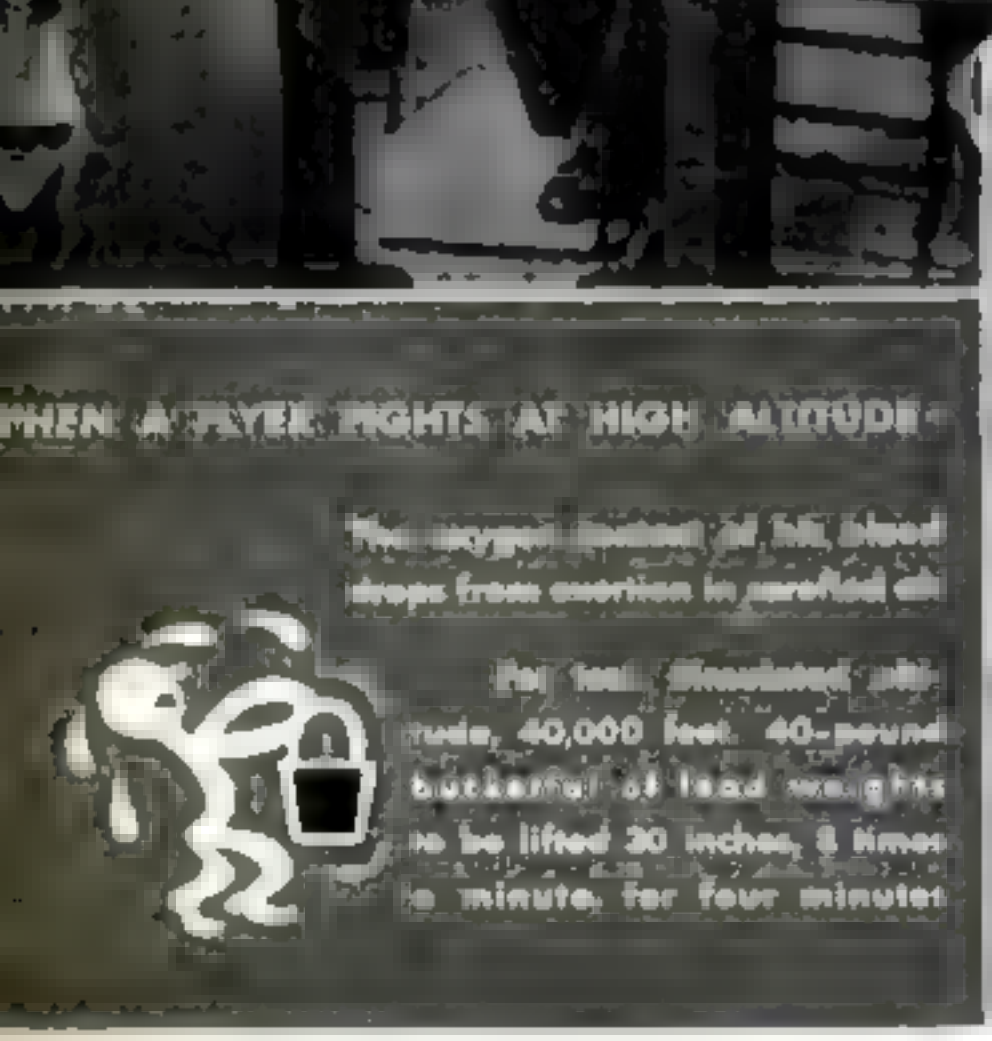
AMOUNT OF OXYGEN in the sample is shown by Haldane apparatus, for comparison with the total amount of air in test bag.





Clamped on the ear, the oximeter measures the oxygen content of a subject's blood as he performs work in a high-altitude chamber

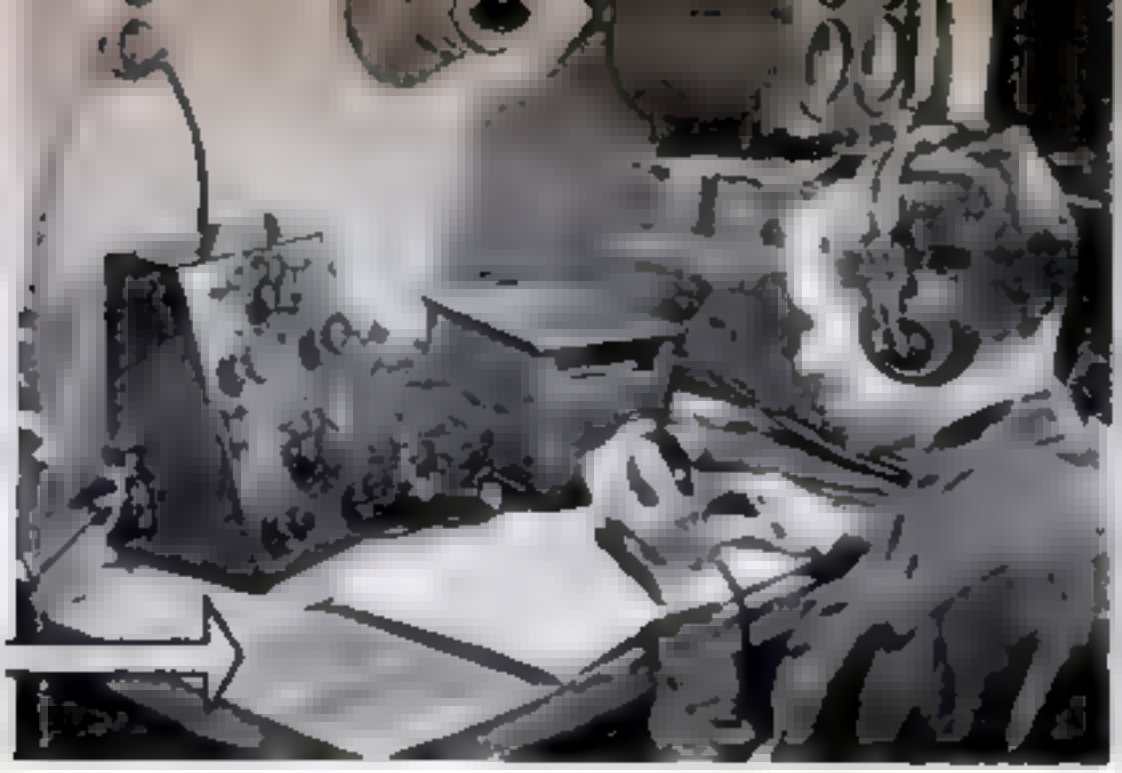




Chemical analysis checks the oximeter test for accuracy. Here the doctor inside the test chamber is taking a sample of the subject's blood. This goes to the laboratory

not this is the final solution, the flight surgeons heavily load the diet of pilots with butter, eggs, carrots, and spinach to supply large quantities of vitamin A. The flyers grumble good-humoredly about "duty food" and put away large platefuls of salad greens.

The structure of the eye also is important in night vision, especially the placing of the rods and cones, sensory bodies in the retina. The human retina, unlike that of lower animals, has at its center a yellow spot called the macula lutea, made up almost entirely of cones. This macula gives us acuity of vision, enables us to read; but it is no good for night vision. The periphery of the retina is amply supplied with rods, sensitive to light and movement, which provide the warning mechanism of the eye. It is here the visual purple is found.



. . . while, on the outside an observer takes the oximeter readings from a galvanometer (right). Pressure in the chamber simulates conditions at 40,000 feet

NORMAL READING

Sea level (without oxygen) 95%

10 000 Feet (without oxygen) 70 75%

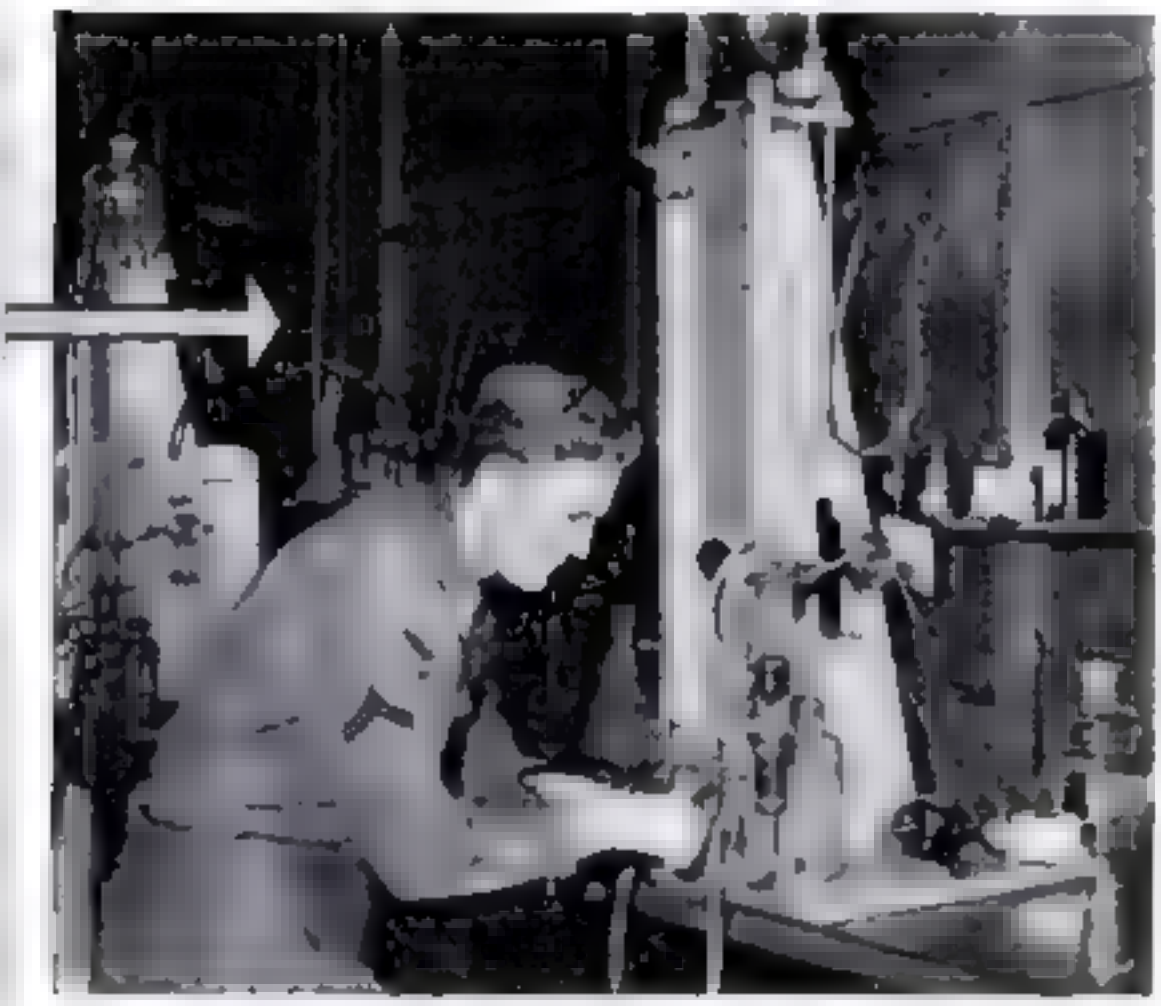
40 000 Feet (with oxygen) 85 88%

RESULT OF DROP TO

70% — Dizziness

60% — Dizziness, Mental Confusion

50% — Complete Loss of Consciousness



. . . where the oxygen in it is absorbed by chemicals in this Van Slyke apparatus. The height of a mercury column gives a reading on percentage of saturation

While looking straight ahead, hold your hand at the side of the head, waggling the fingers. Then bring it forward. You will be conscious of motion and a light image long before the fingers come into the field of the macula, which focuses them sharply.

From these facts of anatomy the surgeons have been able to teach the pilots a trick for seeing in the dark, a device used by the astronomers of ancient Egypt for hunting dim stars with the naked eye. Often the corner of the eye will pick up a dim light at night, but that light will disappear if stared at directly. The way to see faint illumination at night is to look, not straight at it, but about seven degrees away from it.

Night vision has been found also to have a close relationship to oxygen supply. The daytime flyer has no special need of artificial oxygen supply below 10,000 feet, but the night flyer must use it from the ground up. Night vision starts failing at 4,000 feet without oxygen and at 10,000 has fallen off decidedly. The man who has been using oxygen, if glared by searchlights at 10,000 feet, will get back his vision in three or four minutes. Without oxygen it will take him more than ten times as long.

Now that American planes have attained a top diving speed of over 600 miles an hour, and the structural strength to pull out of such a dive, it is a commonplace that our ships are better than the men who fly them. Speed itself is no hazard, so long as the cockpit is inclosed; all of us are moving 12.4 miles per second with the surface of the earth. But the instant high velocity varies from a straight line, in a zoom upwards or a horizontal turn, the ordinary pull of gravity is multiplied by centrifugal force—by five, six, even ten times or more. In a seven-G turn a pilot's weight is multiplied seven times. His blood weighs as much as molten iron.

Continue this force more than an instant, and the pilot sees mist before his eyes, then a graying, then a "blackout," leading toward complete unconsciousness, as blood

is drained irresistibly away from the brain.

A healthy young pilot can usually stand from 5½ to six G's for three seconds without blacking out, but he probably pushes himself and his plane harder than that. The pursuit pilot takes the blackout for granted, as merely a part of the day's work.

The flight surgeon has never been willing to accept this view. He is supported by recent British studies with a motion-picture camera fixed on a pursuit pilot in action. In relation to time and instrumental recordings of the force applied, the films graphically show the face muscles sagging under multiplied weight, the blank expression of the eyes, the lapse into the unconscious. Blackouts last longer than pilots suspect. Often they pass out completely without realizing it. Such things mean loss of combat efficiency, and the blank moment may be the instant when the fight is lost.

A slight change in posture may greatly increase the pilot's resistance. Merely raising the feet six inches has increased resistance 1½ G's. Prewar studies with a centrifuge in the Air Research Institute in Germany showed that a person lying on his back could stand a pull of 15 G's for thirty seconds—though beyond ten G's he found it almost impossible to lift his chest against the force for breathing. Standing is the worst position; a sudden force of 4½ G's has been known to break a man's leg. Pilots carrying infantry and parachute troops on their feet have to watch out for this.

Anything which shortens the blood column in relation to the pull of centrifugal force increases the resistance to it. One reason for this is that the heart provides a limited amount of blood pressure, and the head to function properly needs pressure equivalent to a column of water 50 centimeters high.

The man with 160-cm. blood pressure at the heart has 110 cm. available to lift his blood to the head. At one G, normal gravity, he needs 30 cm. to lift the blood; at two G's he needs 60 cm. Theoretically he will reach his limit at about 3 2/3 G's.

An important factor is the draining downward of the heavy blood out of the head, into the lower parts of the body, and its difficulty in rising back to the heart. If the force continues, the blood vessels in the abdomen expand and pool large quantities of blood, reducing the supply back to the heart and thereby cutting pressure. A circulatory collapse may result from this, causing long unconsciousness, but unless the flyer is in bad physical condition it does not happen in the few seconds of an airplane turn.

If the flyer leans forward, lowering his head ten cm., or four inches, he needs only 20 cm. of pressure to lift blood to his brain. With 110 cm. available he can get up to 5.5 G's in this position, before reaching his limit. If he is one of those individuals whose blood pressure increases under excitement, a total pressure of 210 cm. will give him a resistance of eight G's.

Tall, slender men with long blood columns don't make good pursuit pilots. They black out easily and tend toward low blood pressure. Chunky men tend to run a high blood pressure when excited. Theoretically, the ideal pilot to resist multiple G's would be a squat old man with high blood pressure and hardening of the arteries—blood vessels so rigid they would not expand to pool blood in the abdomen. That is, he might be good until his heart or a blood vessel failed.

All this has dealt with downward forces. If the wing load of a plane is reversed, as in an outside loop, the effect is different. Blood rushes to the head at high pressure. At only three G's the pilot is likely to "red out" and only a slight increase may bring unconsciousness and brain hemorrhage. Pilots flying upside down have to be very careful.

The most practical flying position for dive bombers and pursuit pilots continues to be seated, with feet on high rudder pedals and shoulders bent far forward. Jackknifed in this fashion, the pilot naturally constricts his abdominal muscles, holding in the blood vessels, and this effect may be increased by tightening a belt across the abdomen. Once bent forward, the head and shoulders are automatically carried farther down by centrifugal force.

Men have dreamed of fast pursuit ships flown like a sled, bellywhopper. But a pilot on his stomach cannot hold his head up without special support, and cannot breathe with all that weight on his chest. Seats have been devised which tilt back, but the posture is better adapted for getting a shave than for mortal combat. Lying on the side might work.

Developments of this sort will require changes of cockpit design, controls, and pilot training. Intensive secret efforts toward such ends are being pursued both in this country and in Germany. We have an experimental centrifuge said to be better than that of the Germans; whirling on a 24-foot diameter, it can apply its high forces almost instantaneously. We are not lagging. When you hear of American planes in Libya turning inside the Messerschmitts, that means that the pilots are taking stronger forces than the Nazis. And, despite the flight surgeons, they doubtless still are blacking out. Those young devils drive themselves and their planes to the limit. What the medical men have done is to increase the effective—or usuable—

speed and maneuverability of the airplane.

The frontier of altitude is being conquered rapidly. Two years ago a flight to 30,000 feet was a rarity. Today flights to 35,000 and better are made regularly, by test pilots at least. As for the flight surgeons, their research men work daily in low-pressure-chamber equivalents of 40,000 feet and more. For some time we have been saying that airplanes could fly higher than their pilots. Today it is beginning to be doubtful whether this is longer true.

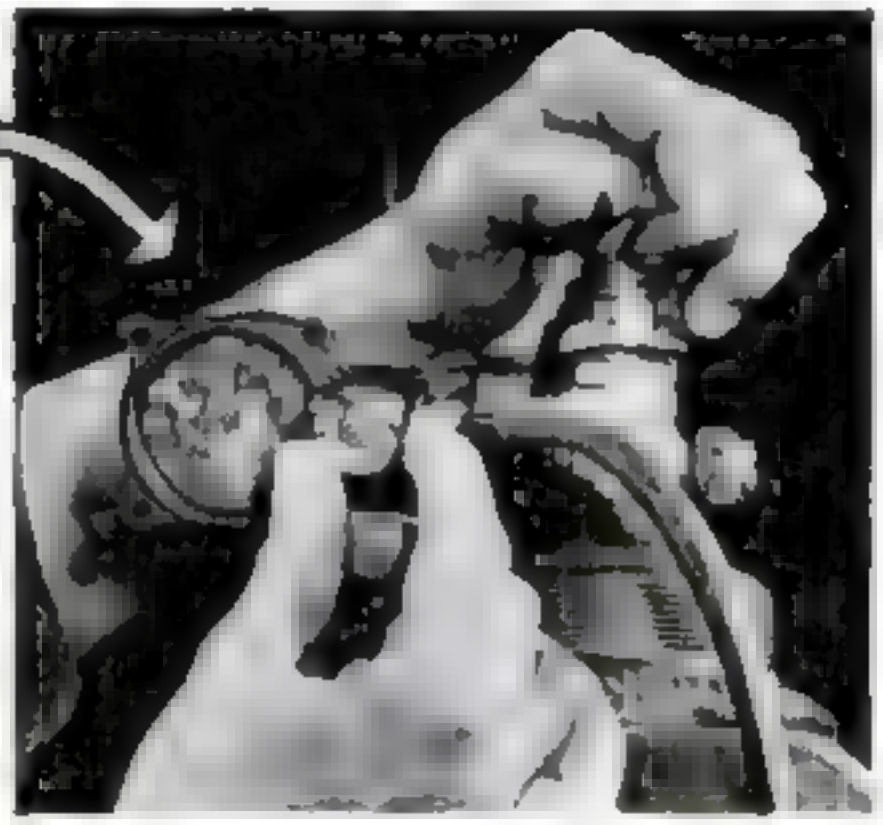
Airplanes have mechanical difficulties at high altitudes which are not all solved by the supercharger. Supercharged air needs to be cooled for the engine after compression, and while bombers easily carry the additional weight of the cooler, it is difficult for pursuit ships. In some ships magnetos and crankcases have had to be supercharged. Fuel has started to boil away at low pressure. Lubrication has failed in the cold. We don't ordinarily hear about the high-altitude attempts which don't succeed.

Medical problems of high altitude have also been largely mechanical. Operations at 40,000 feet are made possible by an oxygen mask. At this low pressure men are coming close to the ceiling of existence, without either pressurized cabins or pressurized suits. Up to 40,000 feet the oxygen saturation of the blood can be kept up close to normal, but after this it falls rapidly and the absolute ceiling is in the neighborhood of 45,000, for selected personnel only.

Man adapts himself to living high in the mountains by producing more red corpuscles in his blood, but daily flights of several hours are not enough to bring this

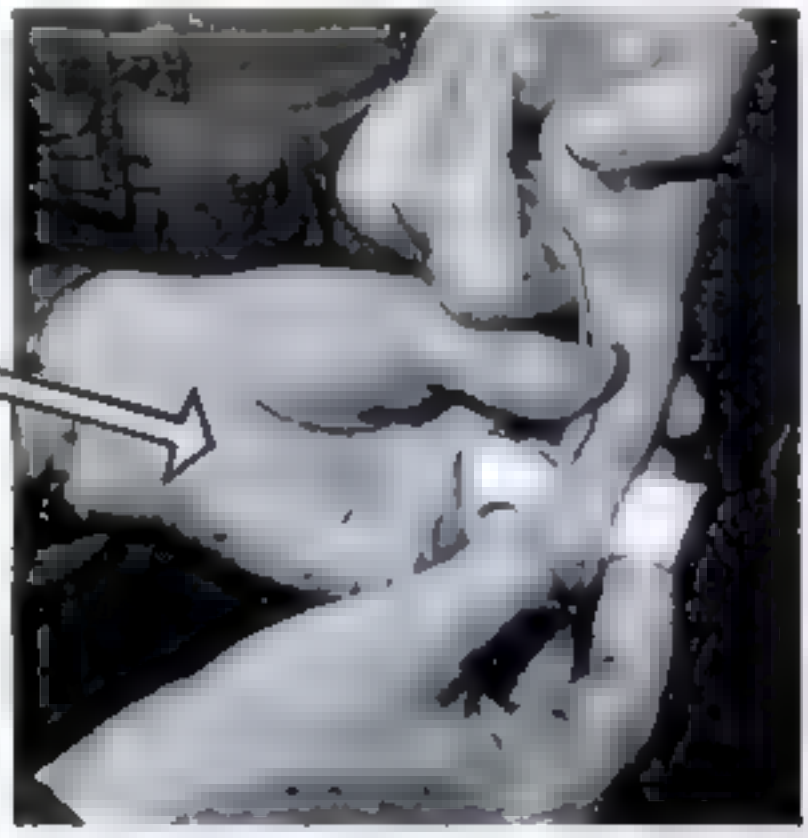
"BIKE RIDE" BEFORE A FLIGHT FORESTALLS DREADED BENDS

By a half hour's pedaling on a gymnasium bicycle, while breathing oxygen through a BLB-type mask, this flyer rids his blood of bubble-forming nitrogen



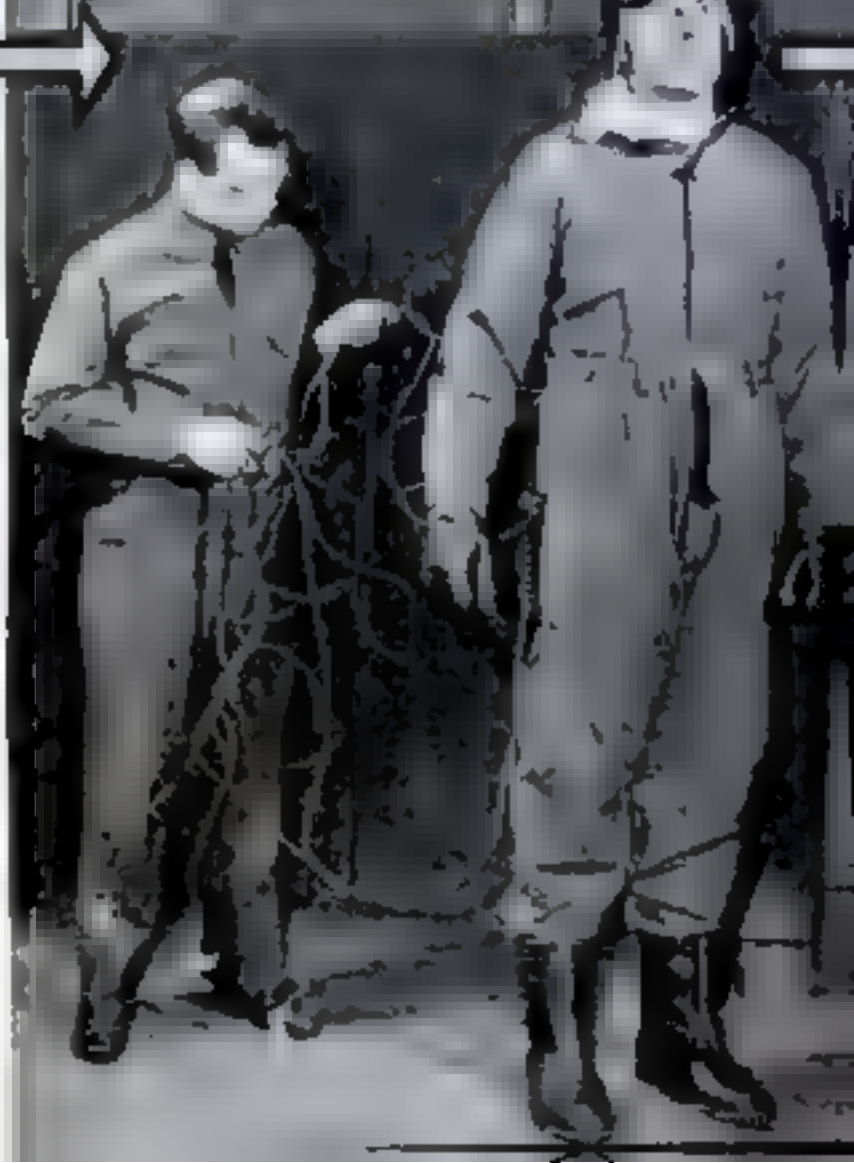
Valve regulates oxygen supply to mask. The small knob is set to the desired altitude; large dial registers the cylinder pressure and rate of flow

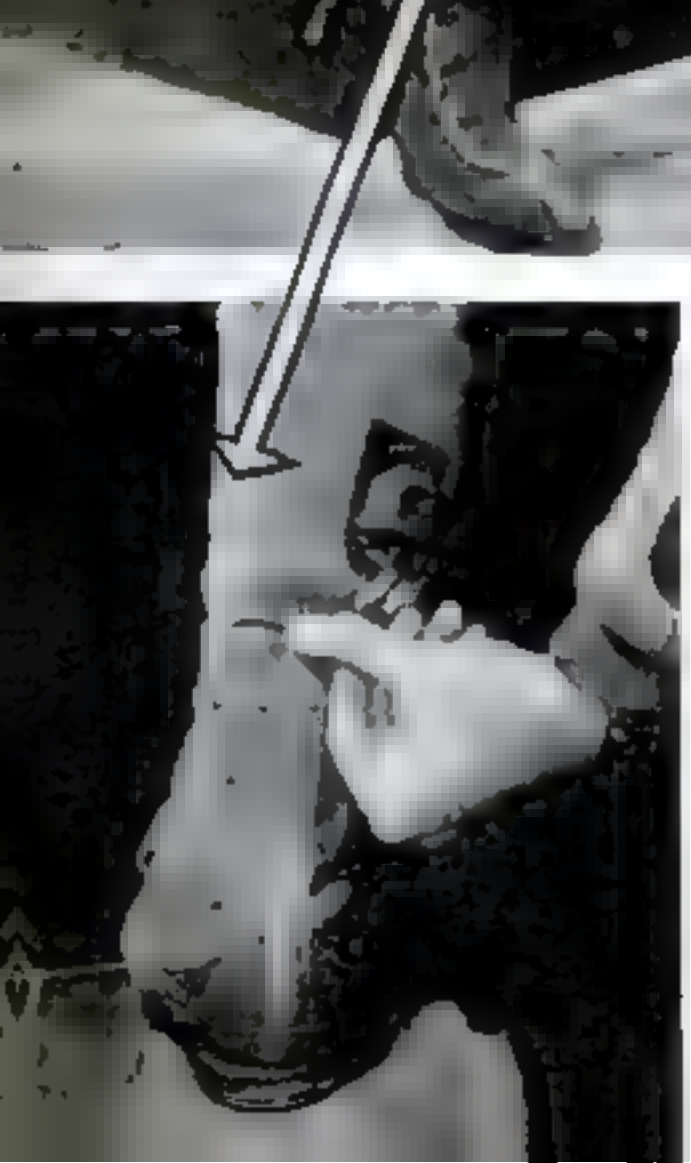
FLYING SUIT heated by electricity gets its current supply through a cable connection at hip. Heated glove plugs in at outlet on sleeve as shown above



THERMOCOUPLES taped to finger, toe thigh, and chest register skin temperatures in cold-room tests to show whether heating wires are properly distributed

READY FOR THE TEST Trailing the harness of wires leading to the thermocouples, the subject enters cold chamber





COLD FEET are prevented by heated boots that plug in outlets on leg of suit. In use, the electric suit is worn under a regular jumper suit as seen at the right

about. He is dependent on the laws of physics and the behavior of gases at various pressures, inside and outside the lungs. Even breathing pure oxygen, he comes to the point where he can't get enough to maintain himself, and this development of anoxia, or oxygen lack, proceeds much more rapidly in the last 10,000 feet than one might suppose.

To understand this, let us start theoretically at 51,000 feet and work down. At this altitude the atmospheric pressure is equal to a column of mercury 87 millimeters high. Now at all levels, from the ground up, the space inside the lungs is saturated with water vapor, with a constant pressure of 47 millimeters. Body metabolism produces carbon dioxide at a rate which keeps its pressure in the lungs practically constant at 40 mm. Together the water vapor and CO_2 make up 87 mm. of pressure, and there is no room for any oxygen whatever to get into the lungs.

Now let us come down to 40,000 feet. Here the atmospheric pressure is about 141 mm., enough to allow a lung pressure of 50 mm. of oxygen. That is the critical level, enough to keep the blood 80 to 85 percent saturated with oxygen. Below this pressure, saturation rapidly falls to a dangerous level.

Coming down to 33,000 feet, we find the atmospheric pressure is enough to allow a pressure of 106 mm. of oxygen in the lungs (assuming the oxygen mask is delivering pure oxygen). This 106 mm. is the normal amount of oxygen in the lungs at sea level.

Without an oxygen mask, a man reaches the critical pressure at about 12,000 feet and the ceiling around 25,000, for the atmosphere is only 21 percent oxygen.

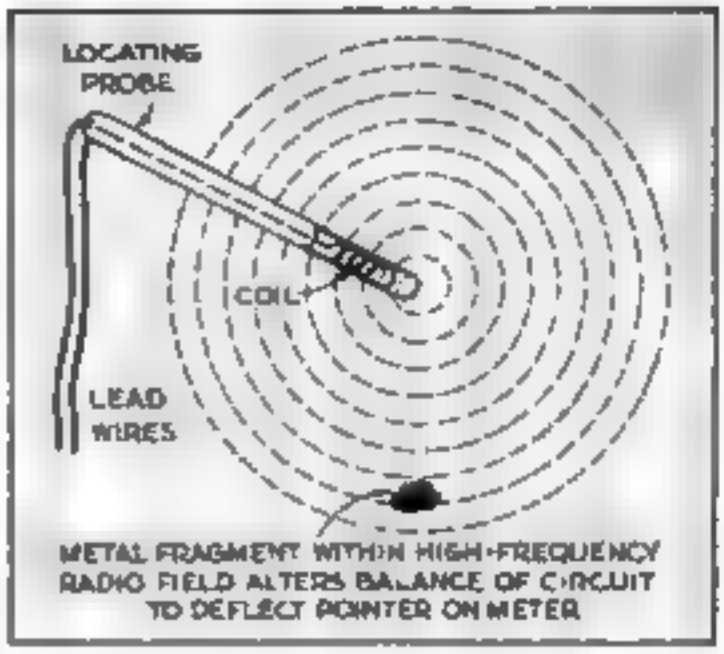
High-flying pursuit pilots don't have to use much physical energy, but bomber crews have to move around, and that work uses up oxygen. In the low-pressure chambers today at 40,000 feet they are studying this use of oxygen in detail. The subject, wearing his oxygen mask, lifts weights to use up the oxygen in his blood. Attached to his ear is a device called the oximeter, which filters light through his ear and measures the changing color of the blood with a photoelectric cell.

Slight efforts make a remarkable difference. Shivering, for instance, is the body's involuntary way of getting warm. This "work" increases the basal metabolism rate by four or five times, and uses up that much more oxygen.

The cold, 55 or more below zero in the substratosphere, is thus intimately connected with the use of oxygen as well as comfort, for heat comes from oxidation. If a flyer gets cold at 15,000 feet, a few breaths of pure oxygen will warm him up. To avoid great bulkiness of clothes, electrically heated suits have been developed. Some of these merely heat the hands and feet, but as to this care must be taken. If the extremities are warmed too much, that stimulates the *(Continued on page 222)*

IN THE REFRIGERATED CHAMBER, with the suit-heater cable plugged in, he sits in the cold. Wires from the thermocouples lead to apparatus outside, where an observer takes readings as seen at right, below. Out of these tests come improved clothing for high altitudes, combining warmth and mobility

Radio Metal Locator Cuts Time in Treating War Wounds

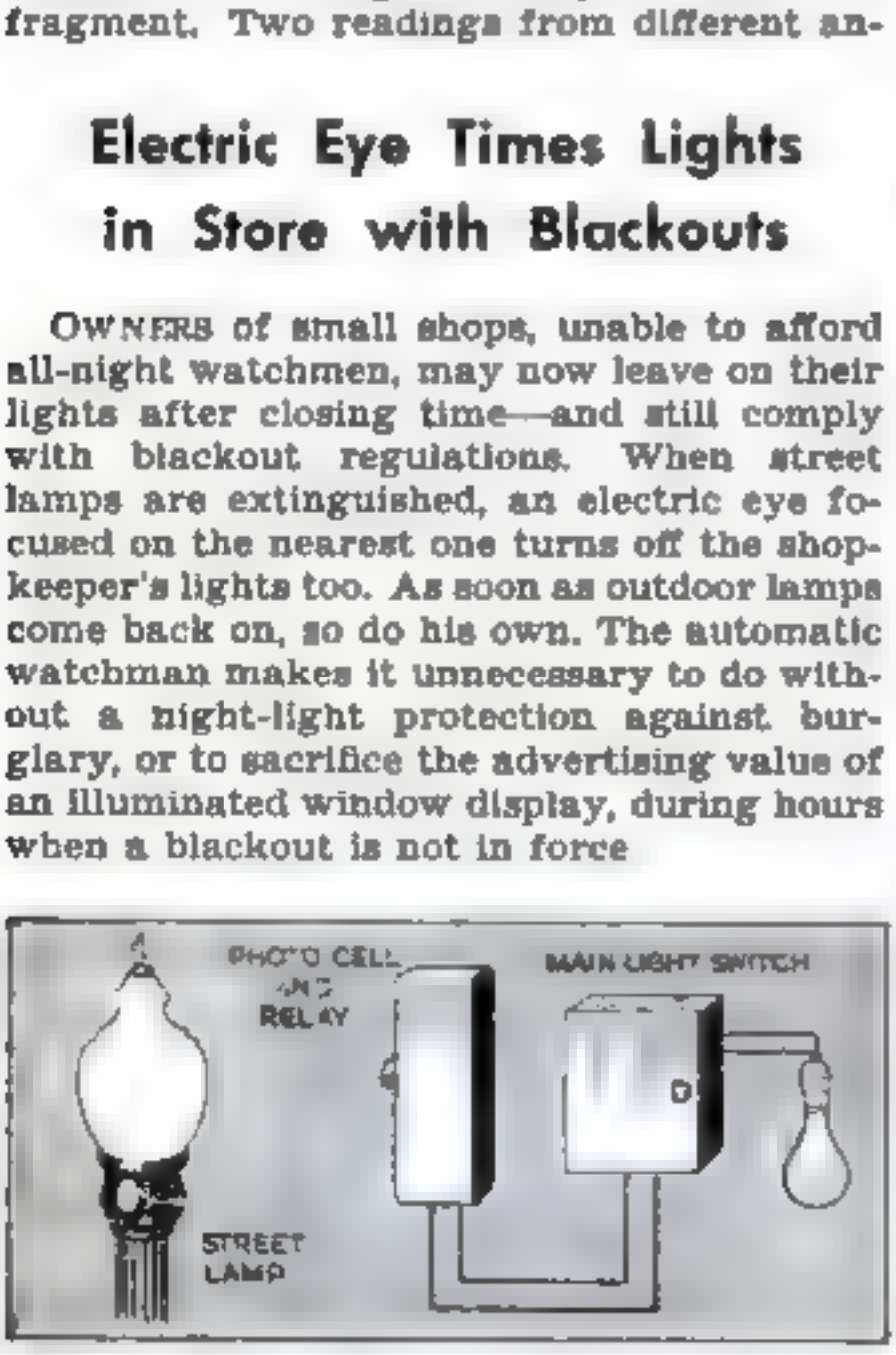


Modern U. S. war surgery employs this radio finder to locate metal fragments and speed treating of wounds. Above, a diagram showing the device's principle

SIMILAR in principle to a radio "treasure finder," a new electric probe takes only a few moments to locate a metal fragment in the wound of a war casualty, eliminating loss of precious time in X-ray examination. When an exploring coil in a steel finger is passed over the body of a patient, a dial pointer swings over as it approaches the point beneath which the metal lies, its greatest deflection being at the spot nearest the fragment. Two readings from different angles show the position and depth, permitting a surgeon to remove the metal in a fraction of the time formerly required. Given its first tryout in the Pearl Harbor raid that started the war with Japan, the instrument successfully located metal splinters in 20 cases and proved them absent in many others. Inexpensive to construct, it may find use not only in war areas but also as standard hospital equipment to perform similar service in peacetime surgery.

Electric Eye Times Lights in Store with Blackouts

OWNERS of small shops, unable to afford all-night watchmen, may now leave on their lights after closing time—and still comply with blackout regulations. When street lamps are extinguished, an electric eye focused on the nearest one turns off the shopkeeper's lights too. As soon as outdoor lamps come back on, so do his own. The automatic watchman makes it unnecessary to do without a night-light protection against burglary, or to sacrifice the advertising value of an illuminated window display, during hours when a blackout is not in force



Focused on a street lamp, the electric eye turns off a store's lights when streets go dark for a blackout, and turns them back on at the all-clear

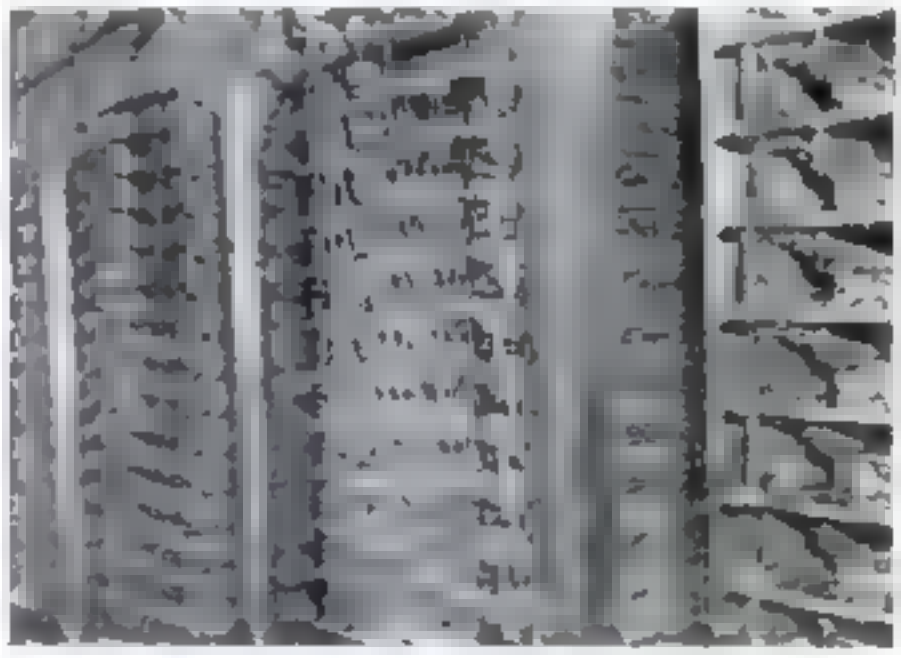
Waterless Crop Yields Oil

An experimental planting of safflower in Los Angeles. Without irrigation, each acre yielded 45 bushels of seed from 25 pounds of seed planted. Safflower crowds out weeds and resists disease, bacteria, and insects

This is the harvest—a pile of safflower seed. Processed exactly like cottonseed, it yields an oil useful in making soaps, paints, and linoleum

TOUGH, oil-producing safflower plants, grown on three experimental plots in Los Angeles, point the way to a new American industry which, if hopes of the California State Relief Administration are realized, will turn vast desert areas into subsistence land for hundreds of families. These plants, which flourish in India, thrive with or without water. Seeds from their thistles, processed like cottonseed, are made into cakes and crushed in giant presses, producing oil useful in manufacturing linoleum, soap, and paints. Estimated annual yield per acre is 270 pounds of oil, 1,000 pounds of by-product cattle-food cake.

A valuable by-product is the pressed cake remaining after the oil is removed. Used for cattle food, cakes are seen here being removed from the press



Safflower oil draining from the press. Rated between linseed and soybean oil in industrial value, it may foster a subsistence crop for drought areas

Cornell University students learn to live off the country. After a hike in the woods, they eat a meal of fish chowder and sassafras tea. They caught the fish, and made tea from roots dug in the woods

Living Outdoors During

NOVEL COLLEGE COURSE TRAINS STUDENTS TO FIND FOOD

By BRUCE ALLEN

TO AID AMERICANS who may be forced to leave their homes and seek subsistence in the woods, as happened to many residents of bomb-torn Norway and Greece, Dr. E. Laurence Palmer of Cornell University has introduced a course to teach young men and women how to live out of doors in all types of weather with only the barest necessities of life. If the United States should ever be bombed to any great extent, these students and others familiar with the outdoors could be called upon to supervise evacuees until they reached a safe refuge.

Students who have been surrounded with modern conveniences are surprised to find out how easy it is to live on what nature provides. The woods are full of food in both winter and summer if you know where to look for it. Heat and cooking facilities are amply provided by the right type of campfire. A comfortable shelter can be erected in a few minutes. Dr. Palmer proves these facts as part of his course in outdoor living

By foraging through the woods in the summertime, a substantial amount of huckleberries, wild blackberries, strawberries, and raspberries may be gathered. Acorns and hickory nuts also can be found available without much trouble. A piece of fresh sassafras root, sliced into boiling water, will make an excellent tea. Spearmint plants, found on the shady border of a running stream, also make a good summer drink

Although most of the vegetation dies in

A tip-up makes it easy to catch fish through the ice in winter. When a fish bites, the stick rises to give warning

an Emergency

AND SHELTER WHEREVER THEY ARE

the winter, clumps of wintergreen may be found in swampy country. By looking in tree hollows, it is often possible to find a wide variety of nuts stored there by an ambitious squirrel.

The lowly cat-tail, found in both winter and summer in the swamps, can be used for a multitude of purposes. The roots can be sliced and boiled to provide a starchy soup. The leaves can be woven together for matting, and the tails, when fluffed out, make excellent insulating material for clothing or bedding.

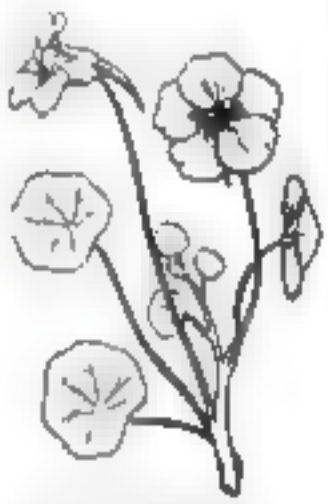
Fish are always a good source of substantial food while living out of doors. In the winter, a hole can be chopped through the ice and a tip-up erected as illustrated. The slightest pull on the line will tip up the stick supporting the line as a signal to the fisherman that something is biting.

A knowledge of fire building is one of the most important items of camping. The hunter's and trapper's

EDIBLE PLANTS

Edible leaves and berries help to eke out a wilderness diet, if you know how to find them. Here is a clump of wintergreen found in the wintertime under the snow. It grows in boggy land, near the ground

WINTERGREEN



NASTURTIUM

Wintergreen and wild nasturtium. The latter, sometimes found in summer in sunny spots near an open field, has leaves that add a spicy flavor to salads. Purslane or pussley, below, is another woods plant that may be pickled boiled, or served as a salad. Wintergreen berries are good to eat, and the whole plant is boiled for tea

PURSLANE, OR PUSSLEY

WARMTH AND SOAP FROM EASILY FOUND PLANTS

CAT-TAIL

WEAVING THE LEAVES

FLUFFING THE TAILS

SCOURING RUSH

SOAPWORT

The common cat-tail is a versatile material for the outdoorsman. Its leaves may be woven into matting or used for chair seats. When fluffed out as shown, the tail makes a good insulating material. Scouring rush and soapwort, at right, are cleaners for the camp cook

fire is most generally used for cooking purposes. Two logs are placed parallel to each other to support your cooking utensils.

For warmth and illumination the reflector fire gives the best results. The reflector is simply a log fence built behind a blazing fire.

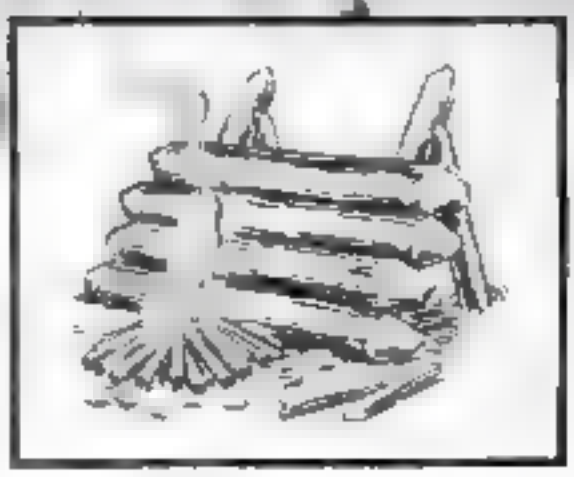
For shelter, a simple lean-to can be erected by lashing three long poles together in a triangular form as illustrated. A tarpaulin can then be stretched over the top and fastened to the ground by ropes and stakes. Hemlock boughs may be used as windbreaks if the tarpaulin does not touch the ground around the sides.

A certain amount of equipment must always be taken on a camping expedition. It should include an ax, blankets, a small quantity of staple foods, several large tarpaulins or a tent, a compass, maps of the surrounding territory, fishing tackle, and such other items as are absolutely necessary.

Courses in outdoor living have started throughout the United States as part of the national defense program.

HOW TO MAKE A SHELTER

Simplest kind of shelter is a triangular frame of saplings on which a tarpaulin may be stretched to make a lean-to. For heat and light in such a shelter, build a reflector fire as shown at right. The leaning sticks support the reflector from the rear, and the fire is built in front of it (see drawing). You will be surprised at the amount of heat and light you can get from even a small fire by using this arrangement



Propless Plane With Hollow Fuselage Is Jet-Propelled

Air enters the nose of the hollow fuselage and is forced by fuel-powered turbines through expansion and contraction passages, being ejected from the tail. The ship has made a nonstop flight of 168 miles

SINCE years before the war, engineers of the Caproni aircraft works in Italy have been toying with strange, barrel-shaped planes. One of the first experimental types had an open cylindrical fuselage with a conventional airplane propeller at its front (P.S.M., Jan. '33, p. 18). Late in 1940, Col. Mario de Bernardi, veteran racing pilot, was credited with taking an improved model—the CC-1—aloft for 10 minutes.

Now comes a completely jet-propelled Caproni plane, devoid of any propeller. According to reports from Italy, the CC-2 weighs 11,000 pounds and seats two persons. Through a circular aperture at the nose, air enters the hollow fuselage and passes through a tunnel with alternating bulges and contractions. Gasoline-powered turbines give the air jet a boost, and add their own hot exhaust gases for increased power. Streaming from the tail, the resulting gaseous jet propels the craft much like a rocket—except that the Caproni model is said to function best at lower levels.

With increasing demand for speed, Italian sources declare, radical new types of planes may be expected, and the Caproni design represents one promising effort. This claim hardly is confirmed by an average pace of 130 miles an hour maintained by the CC-2 on a cross-country flight of 168 miles. However, the novelty of the design is sufficient to interest the aeronautical world in further scheduled tests.

WANTED: A $1,000,000 GAME

By HAROLD S. KAHM

"MONOPOLY" was a million-dollar game, and one of these days some home craftsman is going to come through with another one that may even top this winner. Americans spend $15,000,000 a year on games, and that figure is going up; it's going to rocket, in the opinion of many game experts. The war is one reason. Blackouts in coast cities are causing huge numbers of people to stay home nights, and staying home creates a demand for home entertainment, and lots of it. The curtailment of pleasure driving is another factor. The demand is for games, new games, and more games. And sometimes it takes no more than a few days to invent a new game worth thousands of dollars! This doesn't mean it's easy, but it is well within the scope of the home craftsman who has a fertile imagination and an inventive mind.

It is a little-known industry, this making of games. There are more than 100 manufacturers engaged in it, employing thousands of people. About 100 brand-new games are introduced every year, and the public—kids and grown-ups alike—gobbles them up.

The game industry consists largely of the buying and selling of brains, for a game is often little more than an idea expressed in terms of cardboard and paint; it seldom affords the inventor a severe mechanical problem. The big, important element is an idea, cleverly worked out in terms of simple materials—and fun.

Game manufacturers receive thousands of game ideas, often in the form of working models, but the great majority of these are not acceptable because they aren't new ideas; most inventors fail because they don't go to the trouble of first finding out if their big idea is new. It is as though an isolated farmer, completely cut off from the world, invented the telephone—in 1942—and tried enthusiastically to sell his "invention."

This common error can easily be avoided, if the prospective inventor will acquaint himself beforehand with the current market. A visit to the game department of a sizable store will give anyone a pretty good idea of the situation. Describe your idea to the

HERE ARE FOUR TYPICAL GAMES THAT ARE SELLING FAST

"Treasure Hunt" is played with cardboard pieces bearing letters of the alphabet, with which the players spell out names of objects given on cards

"Tripoley," a combination of poker, hearts, and Michigan rummy, is specially good for parties as it can be played by four to ten persons at once

manager of the department. You will find out in three minutes just how new your proposed game is.

There's real money waiting for the inventor of a clever new game, but it must really be new. "Monopoly" is said to have netted its inventor $200,000 in royalties; the average moderately successful game won't run that high, but it may net its inventor $1,200 to $2,500 a year for a period of one to five years. The average game doesn't remain popular for more than five years, unless it is a smash hit like "Monopoly," which is still selling after some nine years.

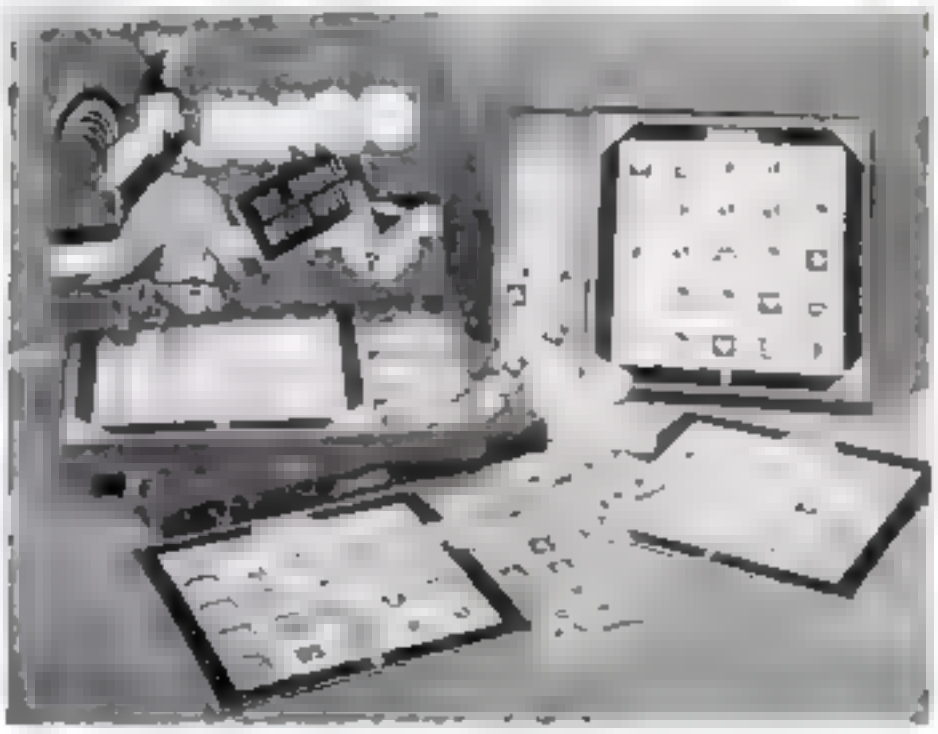
Charlie Wells, game inventor, believes in giving a manufacturer a personal sales talk. At right, above, he is explaining his newest idea to L. K. Anderson, of the firm of Selchow & Righter, game manufacturers

The inventor of a new game usually receives a royalty amounting to five percent of the business done by the manufacturer The latter assumes all risks, makes all the necessary investment, takes complete charge of sales promotion and advertising; the inventor simply collects his royalty. Inventors are not advised to manufacture their games themselves unless they have plenty of capital and business experience. The reason is that it is difficult to market a single game profitably; all the selling costs must be borne by that one game, whereas an established manufacturer may distribute his merchandising costs over a whole catalog of games.

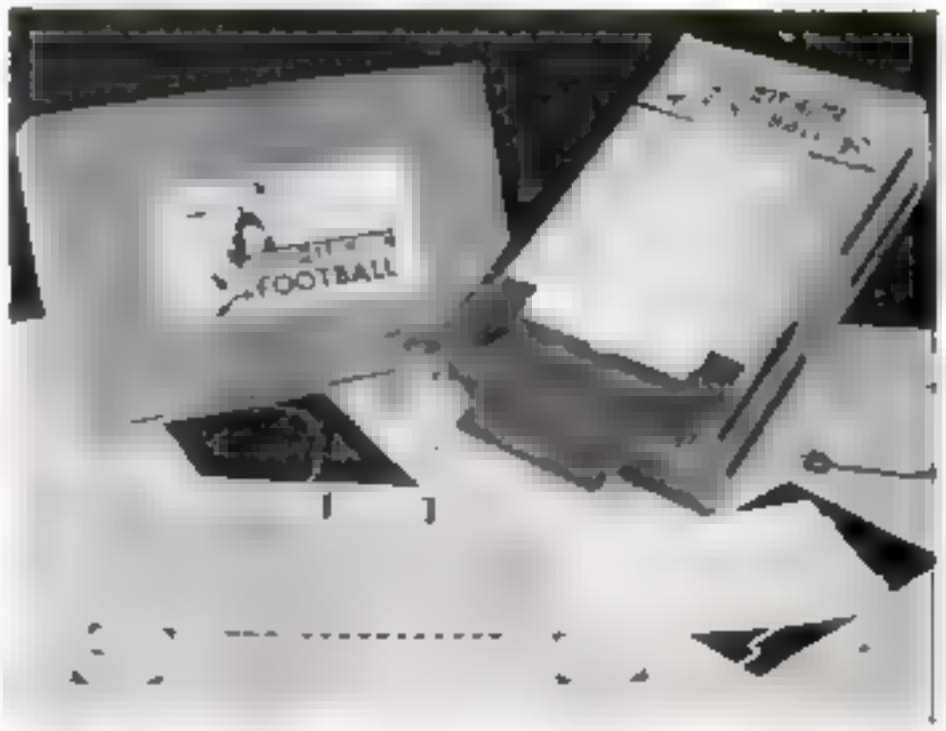
Experience has shown that the most successful games are those which reflect the spirit of the times. "Monopoly," for instance, owed much of its enormous popularity to the depression. People were broke, and "Monopoly" gave them the opportunity to deal in huge sums of money, creating an illusion of big business, prosperity, and

In 1883, when there was a widespread interest in banking on the part of the public, a new game made a hit; it was called "The

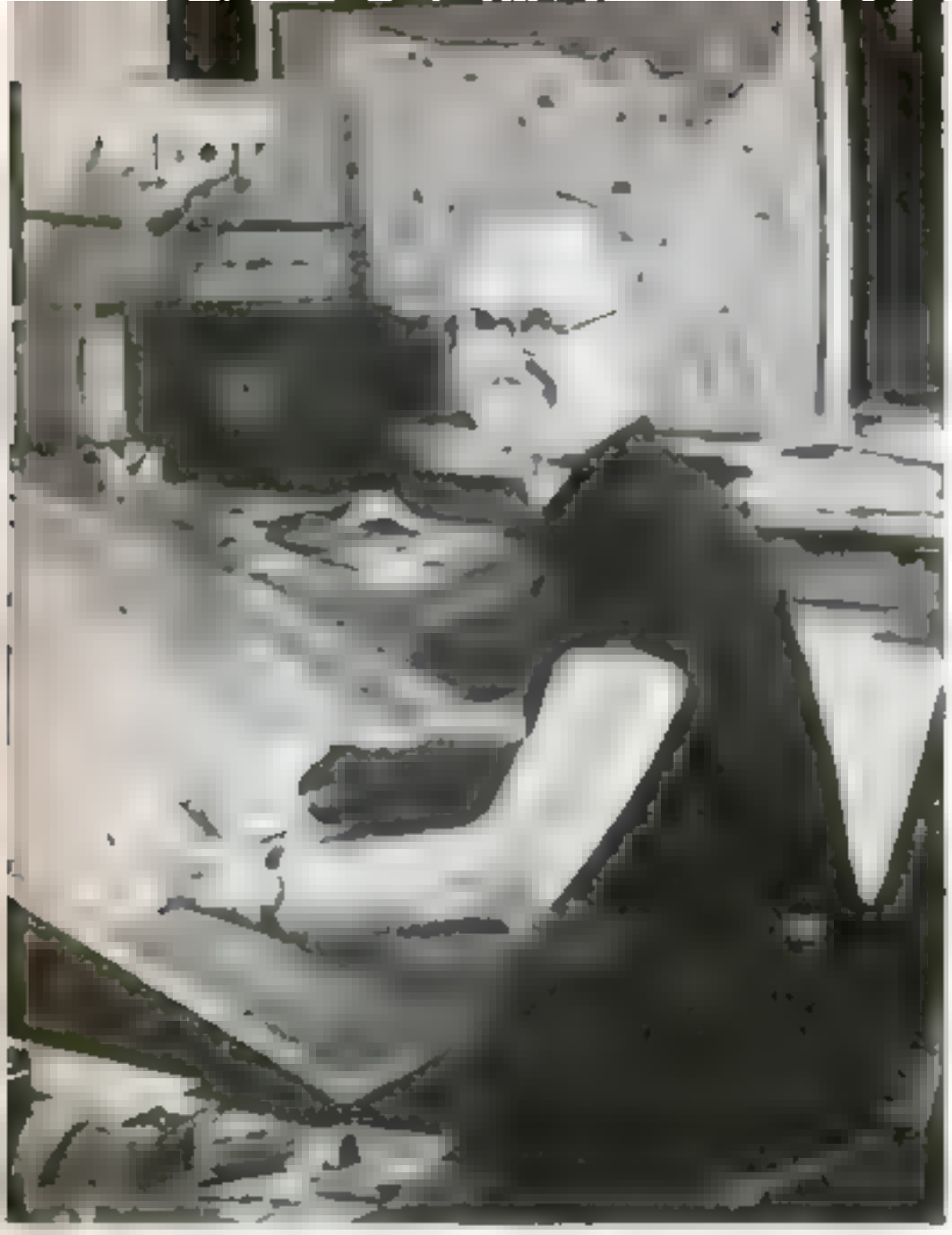
AS AMERICANS SEEK WAYS TO AMUSE THEMSELVES AT HOME



"Jingo" combines jigsaw puzzles and Bingo. Instead of filling in a numbered card, the player fits odd-shaped pictures into corresponding spaces



In "Foto-Electric Football," players select cards representing offensive and defensive plays. In a viewer, a lighted picture shows the resulting play



C. Leslie Crandall is one of the nation's foremost creators of games. He's at work here on a brand-new geography game that you may be playing soon

Game of Banking" and it was invented by a high-school youth by the name of George Parker. Young Parker made up the games and sold them himself: he sold 500 the first three weeks and it was the beginning of his career he is today the head of the famous firm of Parker Brothers, Inc., game manufacturers

Still earlier the religious spirit dominated the nation. In 1843 a minister's daughter invented "The Mansion of Happiness," the first "board" game in America. The player started at a square decorated with the figure of "Justice," turned a spinner, and moved his counter forward on the track the number of spaces it indicated. If the counter reached "Cruelty," he had to go back to "Justice" and start all over again. If in the course of the game his counter reached "Idleness," he had to move his man back to "Poverty." If he became a "Sabbath Breaker" he lost three turns, but if he reached "Piety," "Honesty," or "Temperance," he gained an extra six spaces toward his goal—"The Mansion of Happiness."

During Roosevelt's first term there were several successful games based on the "New Deal." War games are naturally having a good play at this time, as they did during the last war.

The best game to invent is one that appeals as strongly to children as to adults; all children are game-minded, and a game that appeals solely to adults naturally has a smaller market. A game that appeals to a specific group, such as one based on some particular sport, is less profitable usually than one with a general appeal to all classes of people.

Manufacturers report a current demand for electric games, and for new card games —provided the latter are really new, and not just another type of "Old Maid". The most popular games are in the 50¢ to $1.00 group, so keep your game as simple as possible from the manufacturing standpoint.

It is possible to sell an idea for a game to a manufacturer who may design a game around it or include it as a part of some game already being worked on by staff inventors. Such an idea may bring anywhere from $25 to several hundred. An idea alone is usually sold for a flat sum, instead of a royalty arrangement.

A new game or game idea can be protected for a year by this method: Get affidavits from several friends which will establish the fact that the idea is yours, and also the date when you conceived it. Describe your idea or invention in a letter addressed and mailed to yourself; the postmark on the envelope will prove the date. You can also write out a statement describing your invention and declaring it to be yours, and sign this paper before a notary public.

Here are some suggestions for selling your new game:

1. Take it to the game buyer of a large store and get his opinion of it. If he likes it, try to get a written statement from him to that effect. It's still better to have him declare that he would be glad to order the game, if it were on the market. That's the sort of testimony a game manufacturer may find hard to resist!

2. Make some photostat copies of such written praises. Also photograph the working model of your game.

3. Send a letter describing the game to a suitable manufacturer. (The game buyer can make suggestions as to the best firms to submit it to.) Inclose the photostats and photographs with the letter. You can send these "folios" to several manufacturers at one time; those who are interested will make you an offer.

Just be sure, however, to develop your idea completely before you submit it for sale. Manufacturers demand clean-cut, well-planned games, or ideas for games.

The simplicity of construction of the average game makes it an ideal subject for the home craftsman. The demand for new games is constant; the pot of gold is waiting. The rest is up to you! Good luck!

AUTOS

Keeping Your Car Body Young

Car Rattles: Their Cause and Cure

By SCHUYLER VAN DUYNE

BODIES of modern automobiles rattle and squeak far less than those of earlier days when wood frames supported the sheet-metal exteriors. Car paint stands up better, too. But the car body has not been built that will last without care, and rattles, squeaks, and shabbiness are the telltales of advancing age.

The reasons are simple. For, like its chassis and engine, a car's body has many moving parts. In a standard sedan there are at least 18—four doors, eight adjustable windows, a trunk lid, an engine hood, an adjustable front seat, a cowl ventilator, and two windshield wipers. Each of these is made up of many smaller parts. The grand total runs into the hundreds. And mechanical moving parts demand lubrication and care, whether in an ancient jallopy or a 1942 all-steel-body streamliner. Moreover, many square feet of car finish must be preserved from the harmful effects of sunlight, water, air, and chemicals.

So if your car is going to be of service to you for a long time, you should do more than keep the engine and chassis parts in the pink (P.S.M., April '42, p. 134). Given fuel, rubber, batteries, and lubricants, most cars will then last for years longer.

Frequent cleaning of your car's exterior is a sound investment in car durability. Two points to remember in car washing are: Always use cold water, and always do the work in the shade. The last applies also to car waxing. If after washing, the finish is still dull, waxing will restore its luster. All polishes should be rubbed lightly, liquid ones until dry. Tar or road-oil spots call for treatment with special preparations, available at accessory stores or your dealer's.

Chrome-plated or stainless-steel parts

Above, making a paint scratch test. If your nail catches as it scrapes over the depression, wax won't eliminate the mark. Metal thus exposed can rust

The remedy, left, is to have the dent (if any) removed, the surface around the scratch sanded smooth, and the fender or body panel completely spray-painted

such as bumpers and trim can usually be cleaned by wiping with a damp cloth. Ordinary kitchen scouring powder that you would use on porcelain will make rust spots on chrome plate invisible. Car wax will prevent the rust from reappearing and make the entire surface easier to clean with a dust cloth thereafter, just as it will the car itself. If the automobile is used near salt air, wax protection is strongly urged for both metallic and paint finishes. Old linen dries windows cleanest, although extremely dirty glass may call for special glass-cleaning fluid first.

Scraping your thumbnail lightly across a paint scratch will tell you what form of treatment is needed to remove the mark. If you can barely feel the indentation, the chances are good that wax or polish will remove it. But if your nail catches, the scratch is too deep and waxing will help little. Covering the scratch with touch-up enamel will protect the exposed metal from rust, but will probably leave a badly matched color spot. It is far better to have the gouged place straightened if necessary, the paint sanded smooth around it, and the entire panel or fender re-sprayed to give it a new finish. The important thing is to get any exposed metal effectively covered at once.

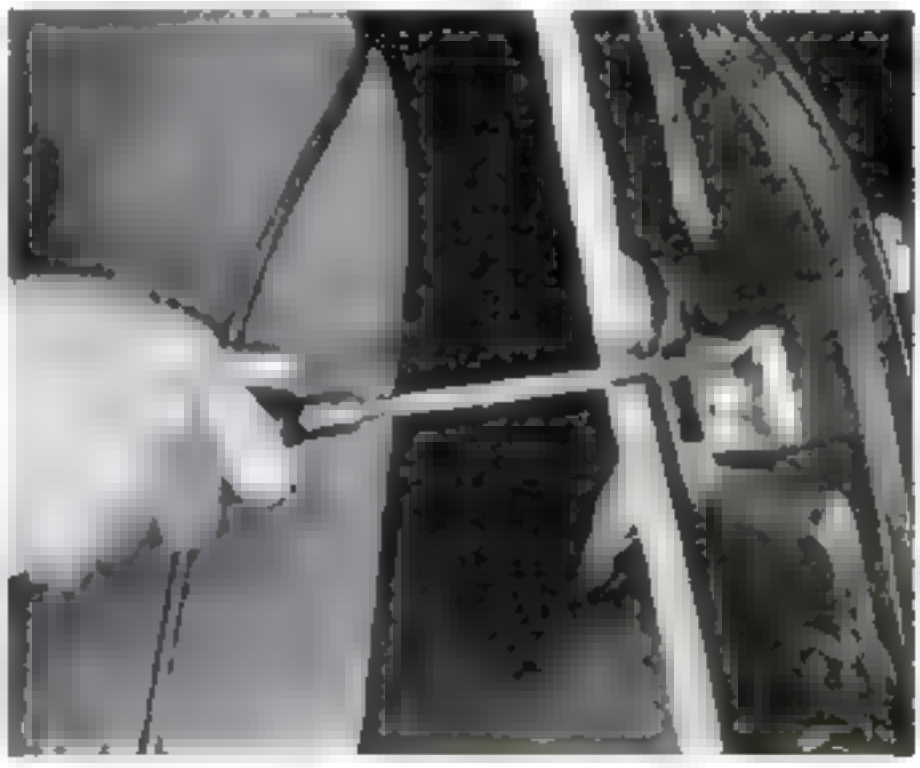
For sticking locks, squirt benzene into the keyhole, then blow it out again with compressed air. Finally, blow finely powdered graphite in with a rubber bulb

Occasional tightening of door strike plates (below), wedge plates, and other car-body fittings will go far toward preventing destructive looseness of parts

The innumerable gears, tumblers, joints, bearings, and levers of car-door latches, locks, and window regulators, were lubricated at the factory to last a long while, but not permanently. The window-control mechanism may be reached with a long-spout oil can through the window slot atop the sill. Another way of reaching the wear points is to touch them with the tip of a length of wire. Oil applied to the wire will follow it down to the vital spots. Use the oil sparingly. Light oil applied to door bolts will carry in as far as needed, and excess oil should be wiped off to prevent spotting clothes. Concealed hinges on many modern cars are of the oilless type. Light oil should be applied to all others. Door checks also require a little light oil, plus pencil lubricant on the check links.

Door locks are best left unoiled. If the keyholes have dust covers, a drop or two of light oil may be used in regions where

There's a good rule of thumb for tightening a car's rubber-insulated body bolts. Turn them as far as you can by hand, then give two full turns with a wrench



cold will not stiffen the lock-tumbler action. When locks become dirty and stick, squirt benzine into the keyhole, blow it out again with compressed air, and, finally, force in a little finely powdered graphite.

Door wedge-plate and dovetail assemblies require occasional lubrication with pencil-type lubricant, sparingly used to protect clothing. One, sometimes both, of the dovetail shoes are of the sliding type, and excessive wear will start doors rattling. Worn-out dovetail units should be replaced, care being taken to line them up properly with the wedge plates. An occasional hand tightening of the screws holding the fixtures in place will pay dividends in car silence, and often prevent harmful door misalignment.

A major annoyance on many cars is the loosening of the sponge-rubber cushion seal around doors. Ordinary rubber cement will not hold them in place, but a special weather-strip cement which your dealer or accessory store handles will do the job.

Frequently, too, where rubber trunk-lid and rear-quarter-window weatherstripping comes in constant contact with painted surfaces the paint deteriorates rapidly and the metal beneath it rusts. The rubber should be washed and wiped clean. The rusted surfaces should then be sandpapered clear down to bare metal and re-enameled. There is no other way to forestall serious destructive corrosion that eventually might eat right through the sheet metal.

Fixed glass such as windshields and back windows rarely causes trouble. The panes are set in rubber supported by metal channels securely bolted in place. When water leaks develop around the glass, however, rubber "dough" injected under the lip of the outside of the rubber channel forms a new sealer which, since it never completely hardens, makes a lasting repair.

With few exceptions, car bodies still are

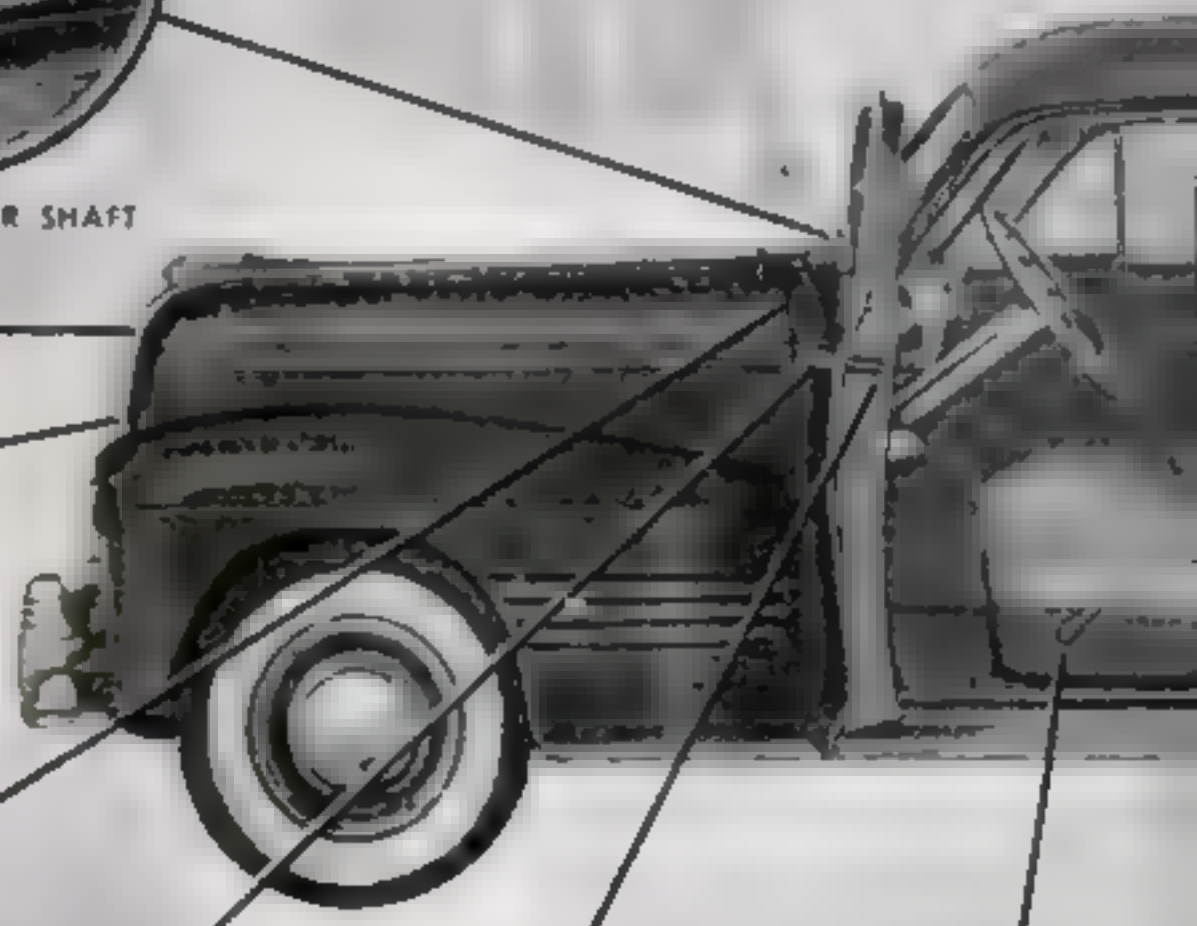
A CAR BODY HAS MANY MOVING

Having the chassis greased only half finishes the job. Door hinges, latches, and many other body fixtures also re-

HOOD LOCK
Light Oil and Pencil Lubricant

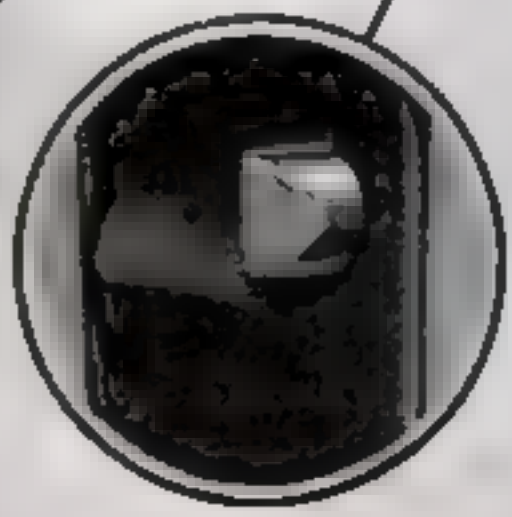
WINDSHIELD-WIPER SHAFT
Light Oil

HOOD CATCH AND PILOT
Light Oil and Pencil Lubricant



HOOD HINGE ASSEMBLY
Light Oil

DOOR LOCK AND HANDLES
Light Oil on Key and Base



DOOR-LOCK BOLT
Light Oil

SEAT ADJUSTER
Light Oil on Seat Adjusting Mechanism

fastened to the chassis by means of bolts, with various types of rubber cushions preventing any metal-to-metal contact. The rubber serves as a noise insulator as well as a shock absorber, so the proper adjustment of the bolts is important. If too tight, they will overcompress the rubber and transmit road and chassis noises up to the car body. If too loose, they will allow excessive play, possibly induce body strains, and even permit damage to the steering mechanism, of which the steering column connects rather solidly to both the chassis and the body of the car.

Windshield wipers rarely suffer mechanical trouble or require service. A few drops of oil at the outside end of the shaft help control moisture seepage. Wiper troubles are generally traceable to the vacuum lines leading from the engine. These are for the most part of metal, while rubber tubing is used under the hood and wherever vibration might break couplings. The rubber should be examined occasionally for leaks, kinks, and collapse.

The sides of the driver's compartment, beneath the cowl, in many cars are made of composition-board panels, which frequently become torn or scuffed. Replacement panels, in case they cannot be bought, are easily made of stiff cardboard or Bristol board, using the original piece as a template for cutting to shape and for drilling the screw holes. The new panels are easily fitted into place and can be painted or stained to match the rest of the car interior.

At first glance, there seem to be as many ways of removing upholstery spots as there are stains to cause them. A few salient "don'ts" to observe, however, are:

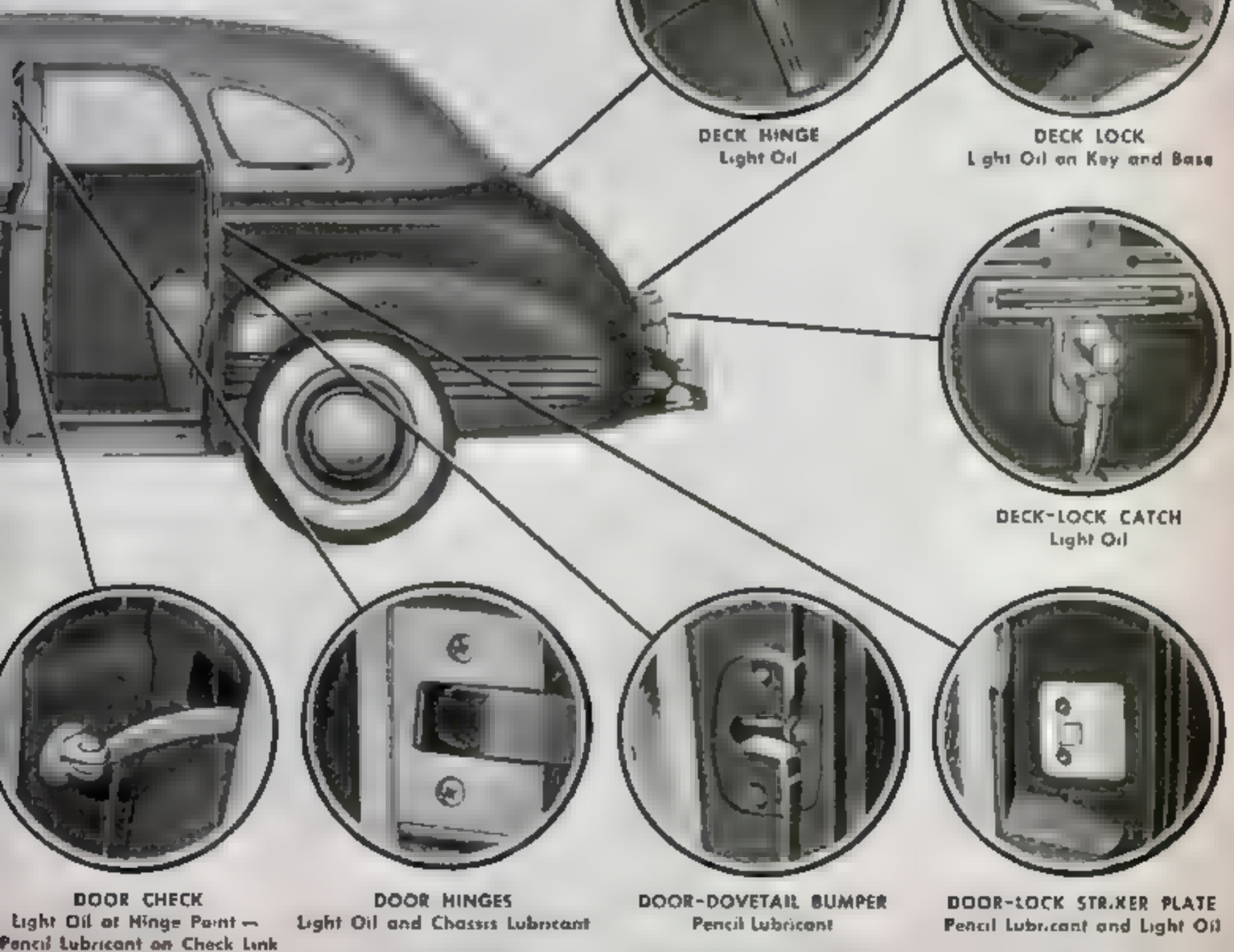
Don't use ethyl gasoline.

Don't use hot water, except for fruit stains and candy stains other than chocolate).

(Continued)

PARTS THAT NEED LUBRICATION

quire oiling. This lubrication chart prepared by builders of Pontiac cars, can be closely followed for all makes



DECK HINGE
Light Oil

DECK LOCK
Light Oil on Key and Base

DECK-LOCK CATCH
Light Oil

DOOR CHECK
Light Oil at Hinge Point —
Pencil Lubricant on Check Link

DOOR HINGES
Light Oil and Chassis Lubricant

DOOR-DOVETAIL BUMPER
Pencil Lubricant

DOOR-LOCK STRIKER PLATE
Pencil Lubricant and Light Oil

To stop windshields or back windows from leaking, a non-drying rubber "dough" is injected under the lip of the rubber channel in which the glass is set. Windshield-wiper shafts need an occasional drop of oil

Chromium plate, as on bumpers and body trim, can be cleaned best with a damp rag. Scratches then scarcely show. Waxing preserves chrome as well as body finish

Don't start cleaning from the center of a spot and work outward

Don't wait until the spot has dried out (except caked mud)

Don't use dirty cleaning cloths

Don't use soap on fruit stains (it may set them)

Don't use much cleaning fluid on seats padded with sponge rubber.

Dirt spots and dried mud are best removed by brushing. Grease, wax-base shoe polish (brown and black), and similar stains are best removed with carbon tetrachloride or ether. Fruit and fruit-candy stains come out best by rubbing with a cloth wet with very hot water. If, after drying, the spot still shows, sponge it with carbon tetrachloride. When removing pieces of chewing gum, hard grease, or the like, soften them up first with carbon tetrachloride and work the material off the fabric with a dull knife while still moist.

Spilled battery acid should be neutralized at once with ordinary household ammonia, then rinsed with cold water on a cloth. Blood stains should be rubbed with a cold wet cloth. Ammonia may help, but repeat the water treatment anyway. Ink responds best to special commercial eradicators, while enamels, paints, and the like respond best to turpentine if caught before drying.

Clean upholstery lasts longer. Use clean cloths, clean water or solvents, and remove spots before they dry out. If soap is used, it should be a good, non-alkaline hand soap

Privately owned cars today are potential weapons of war. In your community, the emergency may arise in which you will be called upon to use yours for any of countless war purposes. For this reason, as well as to keep it serving your personal needs, your car now deserves the best of preventive care. Keep it rolling, too!

First Car Body Was A Seat on a Motor Mounted on Wheels

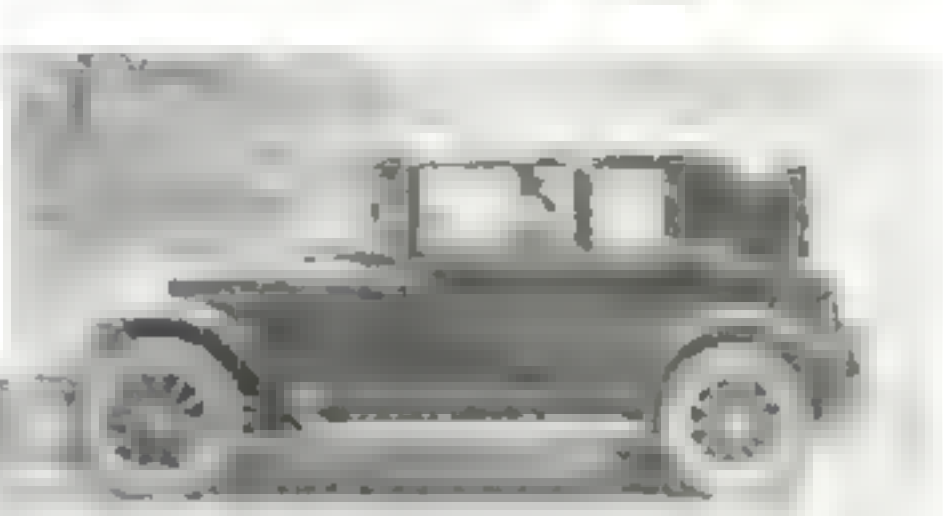
THE first automobile body was just a seat on an engine on wheels. So is the last, though its simplicity is gone. Steel replaces wood and a protective streamline shell surrounds it. It rides on soft springs, rubber, and air. Buttons start and a touch stops it. High spots in its evolution are depicted here.

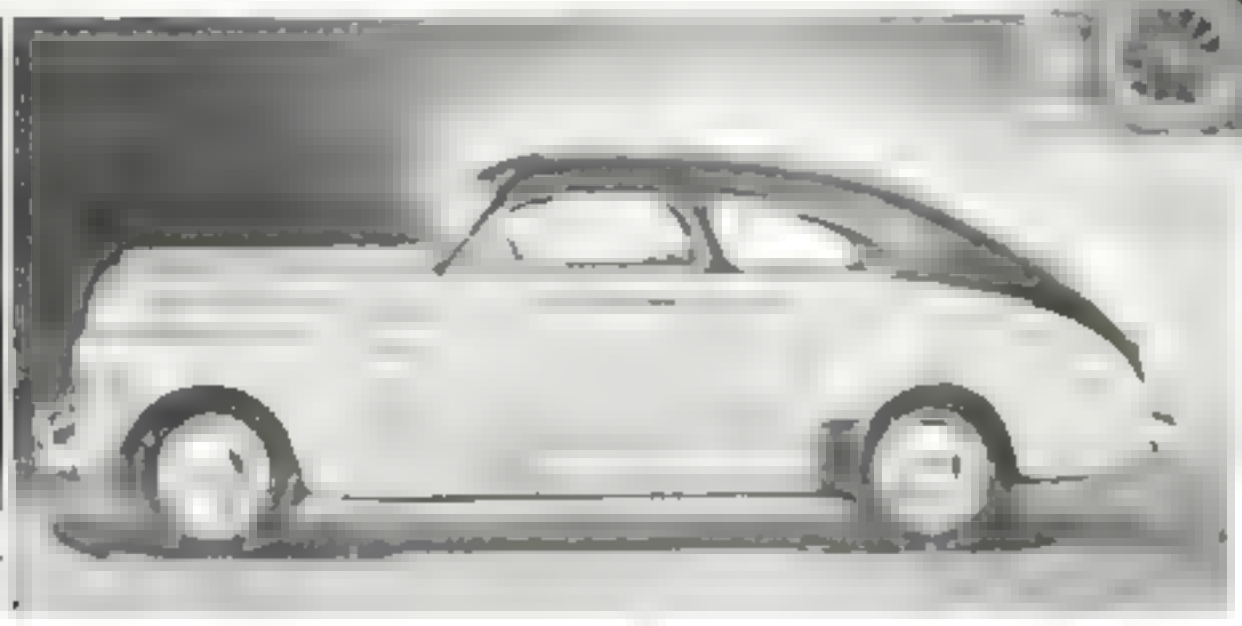
1834 A single seat looking about as comfortable as a park bench was the only "body" this steam-driven car of French design possessed. Note, however, the engine in the front, front-wheel drive, full elliptical springs rubber tires, steps, and fenders over the rear wheels

1896 Henry Ford's first automobile still lacked any semblance of a body. But the seat has moved forward as a nod to comfort, drive is through the rear wheels, steering in front. The engine in the rear is prophetic, perhaps, of tomorrow's car

1905 Buick: The hood has come to stay on all cars and front bucket seats and rear seats, fenders, doors, and artillery-type wheels show that the carriage maker's influence is on the wane. The top, optional at extra cost, folds back if desired. Windshields are still conspicuously absent

1925 Hudson, a year or so earlier, and Essex (illustrated) have pioneered in mass production of cheap closed cars. Many major elements of today's car are here, and for utility it has high value Principal weakness is a body frame made of wood

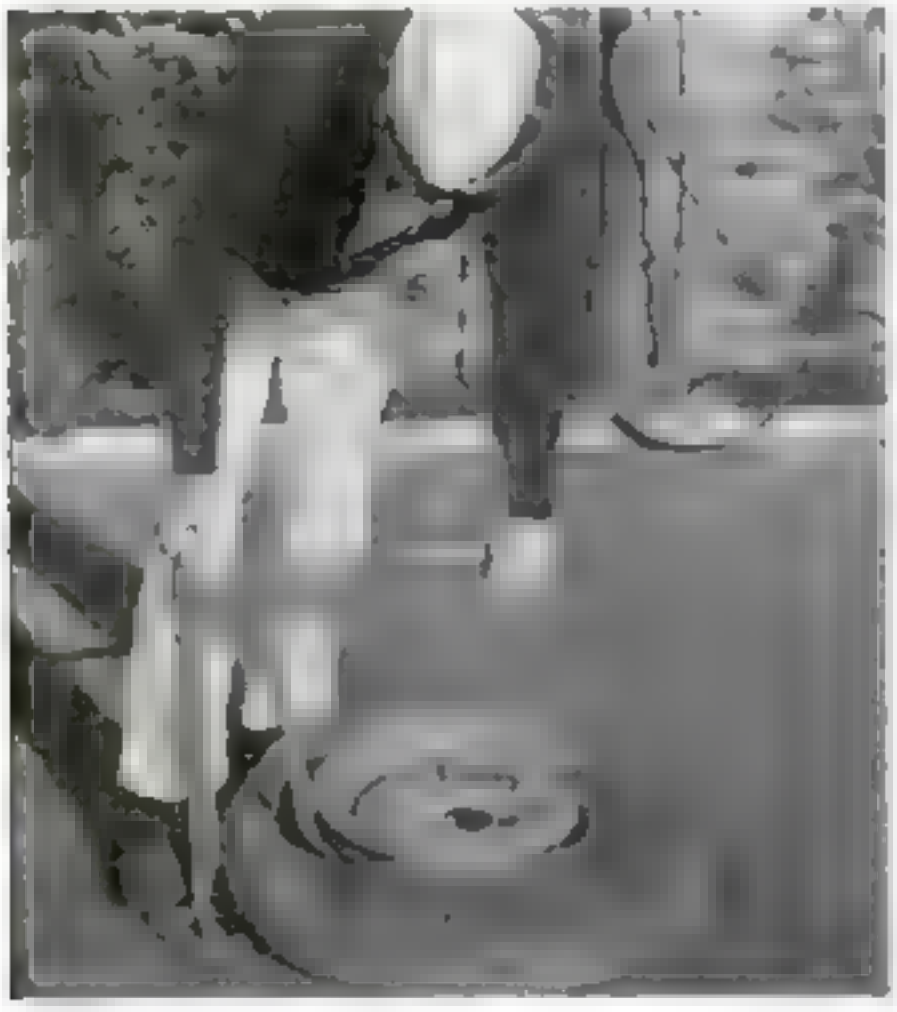




1942 In this safe, all-steel modern car, Chevrolet shows good streamlining. Now, as in other cars, the real beauty is a functional, organic unity that controls the number, type, and arrangement of the car's parts in accordance with what is expected of it. It has almost made obsolete the nation's most modern roads

Auto Ideas

TANKS WON'T OVERFLOW and spill gasoline all over your car fender when a new filling-station hose nozzle is used. The automatic spout, turned on by hand, turns off again as soon as gasoline rising in the car tank comes in contact with it. A vacuum valve controls the shut-off device.

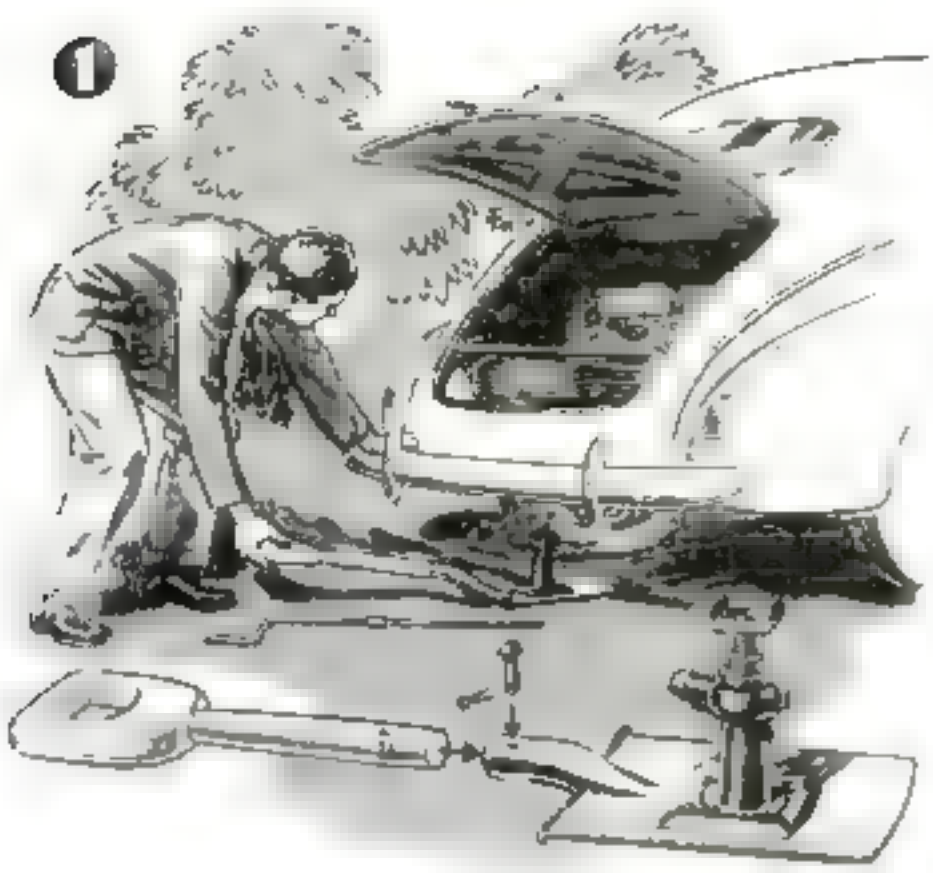


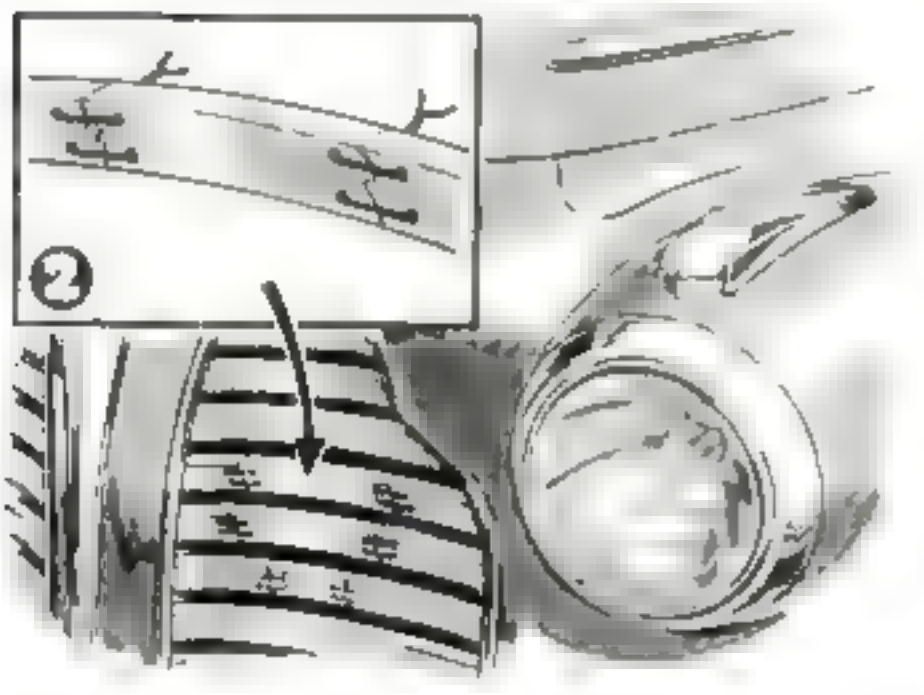
FREEING TIRES FROM RIMS with a simple, one-handed operation is the purpose of a new tire tool for garage and filling-station men. Designed specially to make light work of removing tires from the type of drop-center rims that have inner ridges that prevent tires from slipping off the rims after blowouts, the unit is shown in use at the left. The lever-powered arm that presses on the tire has a spade-shaped end to protect the tire bead.

GASOLINE MILEAGE of the average car can be increased 17.3 percent at an average service cost of $4.08, according to a survey conducted by engineers of the Electric Auto-Lite Company, in cooperation with the A.A.A. and the U. S. Bureau of Standards. Of the total cost, $1.80 represents the replacement of spark plugs. The tests covered cruising, idling, and full-throttle operation of many cars of varying ages, condition, and price, in proportion to national registrations.

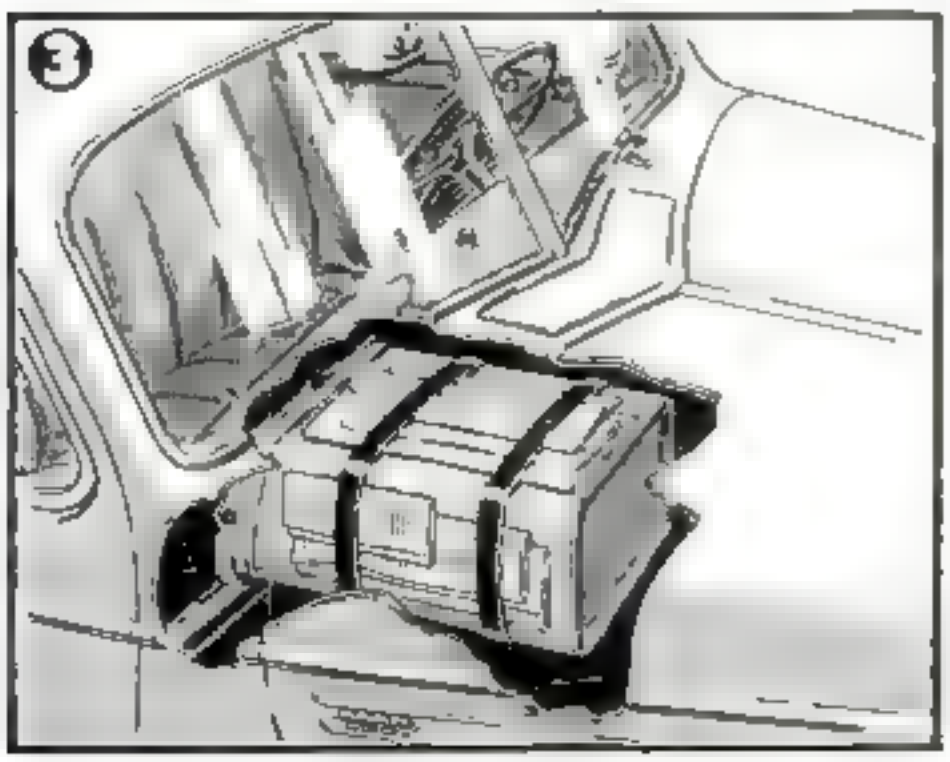
A PORTABLE COMPRESSOR for powering hydraulic tools is now available for car body-repair shops. Supplying instantaneous pressure where needed, the unit carries its own electric pump, switch, and connecting hose nozzle. Weighing only 32 pounds, the compact machine furnishes power for body-straightening tools or power rams ranging from four to 50-ton capacity. Eliminating hand pumping, it is turned on by pressing a button so situated that it can be foot- as well as hand-operated. It is designed for use on 115-volt current, and has an eight-foot extension cord.

HINTS FOR MOTORISTS





DRAWINGS BY STEWART ROUSE

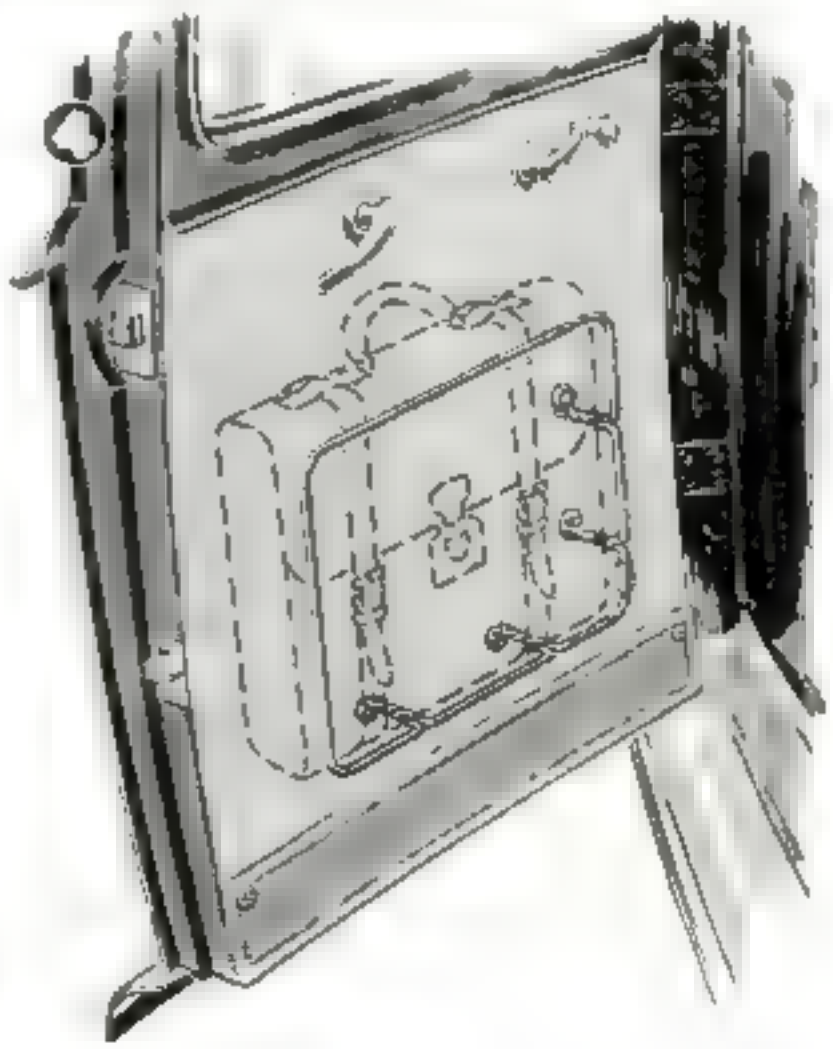


1 **A FIRM BASE FOR A CAR JACK** is provided by an old spade, made so that it comes apart, as shown. The two parts will take up little room in the luggage compartment or under the front seat. When assembled, they form a platform and handle for sliding the jack in place under the car. The broad shovel blade supports the car weight on soft ground, while it may also be useful for digging a stuck wheel from the mud.—A. H. W.

2 **RADIATOR GRILLE BARS** of the cast-metal type can frequently be repaired by drilling small holes near the breaks and wiring the pieces back in place with soft iron wire. Touching up with aluminum or silver paint makes the job neater.—V. P.

3 **LICENSES, ROAD MAPS,** and other papers that clutter up a glove compartment but which belong permanently in your car, are out of the way yet readily available if stuck under rubber bands snapped around the compartment itself, as shown in the accompanying sketch. If heavy bands are not available, cut a pair from an old inner tube.—R. N.

4 **A BRIEF-CASE HOLDER** attached right to the door of the car beside the driver's seat is particularly convenient for traveling business men. It keeps the case upright and off the seat or floor, and always at hand when stops are made. It is easily bent from iron wire with the aid of a vise, hammer, and pliers. Short, self-threading screws fasten it to the door panel.—E. F. G.



GUS spotlights lighting troubles

Get the Model Garage boss and his friend Doc Marvin together for a few minutes and they'll be able to talk on any topic —so long as it's automobiles!

By MARTIN BUNN

"Suppose it's a long job. . ?" "Never mind about me," Gus interrupted, and, at his urging, Dr. Marvin gratefully drove away

GUS WILSON was busily engaged in cleaning up an accumulation of odd jobs in his Model Garage shop a little after ten o'clock one rainy early-spring evening when he heard the office telephone ring. Knowing that his partner Joe Clark was in there working overtime on his month-end bookkeeping, he went on with what he was doing. But after a half minute Joe stuck his bespectacled face in at the door which leads from the shop to the office.

"Doc Marvin's on the wire," he said. "He's calling from Brady's place, out there on the back road, and he says that his car lights have blacked out on him and he can't get them burning again. He's on a rush call, and he wants to know if there's anything you can do to help him out."

Gus knows Dr. Marvin well enough to be sure that when the doc gets in automotive trouble he does his darnedest to get himself out of it before he sends out an S.O.S. "Tell him I'm on my way," he instructed Joe briefly. Then he got together a few tools, a flashlight, and a half dozen new lamp bulbs, put them in his old roadster that runs like a 1942 car, got in himself, and was out of the shop almost as soon as Joe had hung up the receiver.

Brady's place is a roadhouse three or four miles out of town, and Gus didn't waste any time getting there. Doc Marvin was on the porch waiting for him, and hurried out through the pouring rain when he stopped. "My bus is a couple of hundred yards along that side road that leads off to the right," he said as he got in. "Watch the road—it's terrible."

The road was terrible—one of those rutted-mud lanes that you're always surprised to find anywhere close to a big city. "Where were you headed for when you ran into grief?" Gus inquired as the roadster bumped along

"There's a kid sick on a little truck farm a couple of miles out from here," Dr. Marvin told him. "Its father came in to Brady's to phone me, and then hurried back home. He didn't speak very good English and he was scared, so I couldn't make out what's the matter with the kid. But it sounded as if it might be serious, so I started right away. I was going along at a pretty fair clip when I hit an extra bad bump, and my lights went out. I put in my spare bulbs and started off again, but when I hit the next bad bump, off the lights went again. I figured that in the long run it would save time if I could get you to come out here and give me a hand. . . There's my car."

Gus stopped. He picked up his flashlight,

tools, and bulbs and got out of his roadster. "Use my car to make your call, Doc," he said. "If I can get your lights burning I'll drive your bus in to the shop, and you can get it there tomorrow morning. If I can't get them burning, you can pick me up here on your way back to town. O.K.?"

"That's very good of you," Dr. Marvin said. "But suppose I run into a long job. . . ?"

"Never mind about me," Gus interrupted, and, at his urging, Dr. Marvin gratefully drove away.

Gus went over to the doctor's car and examined his head and tail-light connections as well as he was able to in the driving rain, found them in apparent good condition, and put in new bulbs. Then he got into the car, and pulled the light switch. The lights flashed on.

"The new bulbs that Doc put in burned all right, too," he thought. "But maybe these will last long enough for me to make it back to the shop, where I can really work. Might as well try, anyhow."

He switched on the engine, and, easing the car over the many rough spots, drove carefully down the road. The headlights burned brightly—until one of the front wheels thudded down into a deep hole he hadn't seen because it was filled w th muddy water. Then the lights blacked out again.

Gus cussed. Then he checked over the wiring and connections inside the car. They looked all right. He uncovered the battery and examined the cables and terminals. They seemed in good condition. So he again

He perched himself on Gus's workbench and Gus sat down on an old oil drum. "Well, what is a guarantee against lighting-circuit grief?" Doc asked

put in new bulbs, got back into the car, and pulled the light switch. Again the lights burned brightly.

He switched them off and sat in the dark as he did some hard thinking. "The first bump I hit," he told himself, "they'll go out again. Why? What makes electric bulbs burn out? Too high voltage, nearly always. But Doc's been driving this old sedan of his a lot even since he bought that new one, and I've never heard of him having any lighting-circuit trouble before. Too high voltage would have to come from the generator, and—I *am* dumb! That must be it'"

He ducked under the dash and flashed his light on the back of the ammeter. The battery lead was loose on its ammeter terminal. He grinned widely as he tightened the nut. Then he switched on the lights, started the engine, and bumped confidently off along the road.

Gus hadn't been back in the shop more than half an hour when Dr. Marvin drove in. "I see you got 'em to burn," he said, glancing at his sedan.

"That was easy," Gus told him. "How's the kid out there on the farm, Doc?"

The doctor laughed. "That was just another of those false alarms that usually come on rainy nights—the combination of a common bellyache and a pair of first-time parents," he said. "What was the matter with my lights, Gus?"

"That was a case of too much juice," Gus replied. "You have a 6-volt battery and a 6-volt lighting circuit. But your generator generates more than that, so that it can force the current into your battery. The battery lead was loose on the ammeter terminal, so when you hit a real bad bump in the road the lead jarred away from the terminal. That sent the higher voltage of the generator through the lighting circuit, and of course it burned out your bulbs. When you stopped your car the loose lead settled down and made a connection again. All I had to do was tighten the nut on the terminal. Your bus is all ready for driving now."

Dr. Marvin said what he'd be. When he cooled off, he perched himself on the end of Gus's workbench and lighted a cigar. Gus up-ended an old oil-drum, sat down on it, and fired up his pipe. The drumming of the rain on the shop roof drowned out the clatter of Joe Clark's typewriter in the office, and everything was set for a comfortable fanning session.

"Well, what is a guarantee against lighting-circuit grief?" the doctor asked.

"A guarantee against it? Well, I'd say that the best guarantee against it is having your lighting circuit checked often by an expert. When a car is new, you can pretty well take it for granted that it's O.K. But as soon as you start to drive that new car, its lighting system will start to wear out—same as every other part of the car. That's why every car should be checked frequently—to catch the little things that go bad from wear, and to fix 'em before they get bad enough to make trouble.

"Of course, the headlights are the most important part of your lighting system. When everything in the system is just the way it should be they produce the equivalent of 50,000 candlepower—and that's plenty of light for safe driving under any normal conditions. But for them to produce that much light every part of your system must be *right*. Your bulbs must be good, your reflectors bright, all your terminals both bright and tight, and your switches and your cables in good condition.

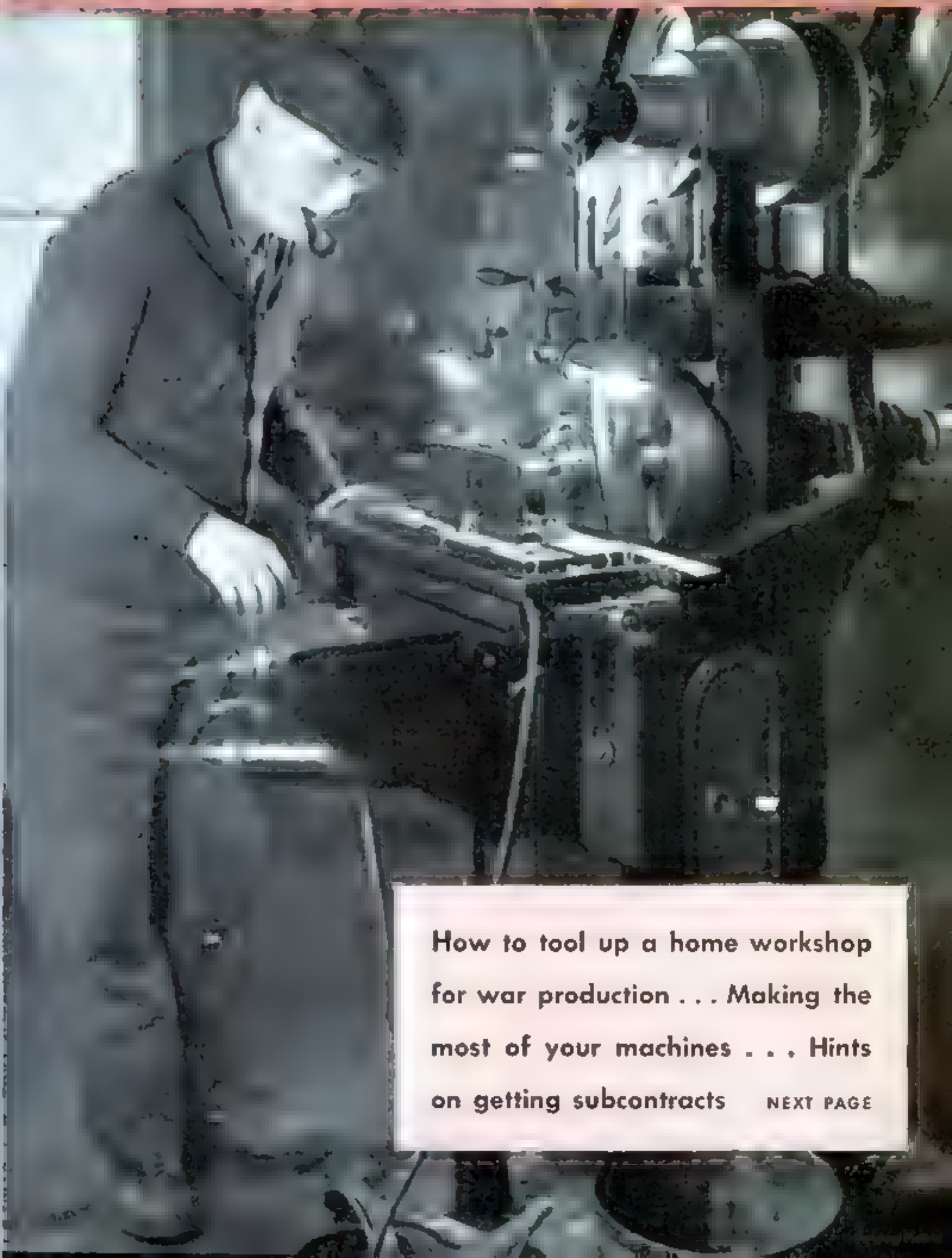
"A noticeable flare-up of your headlights is a warning of trouble on the way. It almost always means that your lighting circuit is carrying too high voltage. Sometimes a sudden increase in voltage will burn out your lamps and leave you stalled on a dark road—that's what happened to you tonight. But more often too high voltage just shortens the life of your lamps. That isn't so serious, but it takes good money out of your pocket. The bulbs used in headlights are designed to operate on voltage which varies—so long as it doesn't vary too much. A 6-volt lamp working in a 6-volt circuit usually has a life of somewhere between 115 and 130 hours. But the same 6-volt lamp working in a 7-volt circuit may not last more than 30 hours!

"So take my advice, Doc—if you notice your headlights flaring up when you speed up your engine, give your lighting circuit a careful checking. Loose or dirty connections are the most usual cause of the trouble—they make the generator voltages build up. You may find them at the ammeter—the cause of your grief tonight—or somewhere else between the *(Continued on page 218)*

GUS SAYS:

Hot-weather driving isn't far away now, which means radiators really buckle down to work. They can't do it properly when they're dirty, so get yours drained and flushed in plenty of time. Remember, engines waste gas if they get overheated!

HOME *and* WORKSHOP



How to tool up a home workshop for war production . . . Making the most of your machines . . . Hints on getting subcontracts

NEXT PAGE

Tooling Up Home Workshops for War Work

Above, a 10" workshop lathe tooled up for production work with hand-lever double-tool cross slide bed turret, and draw-in collet chuck attachment

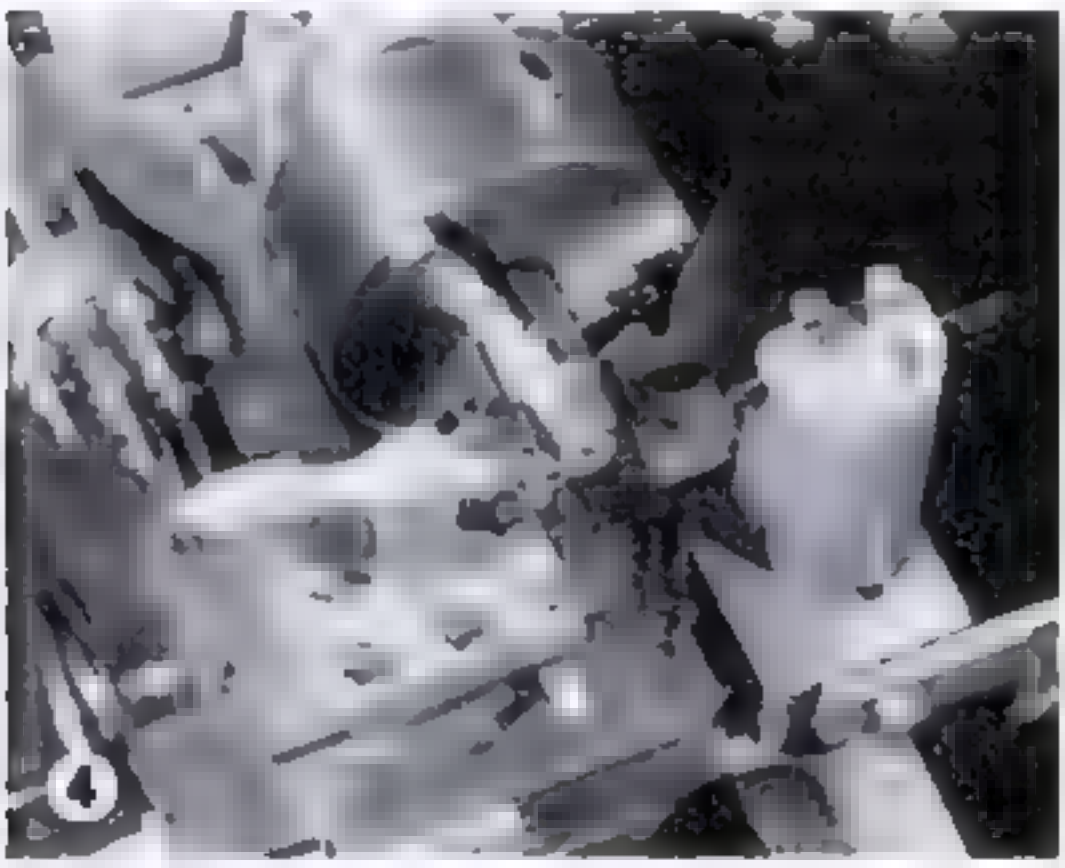
By C. W. WOODSON

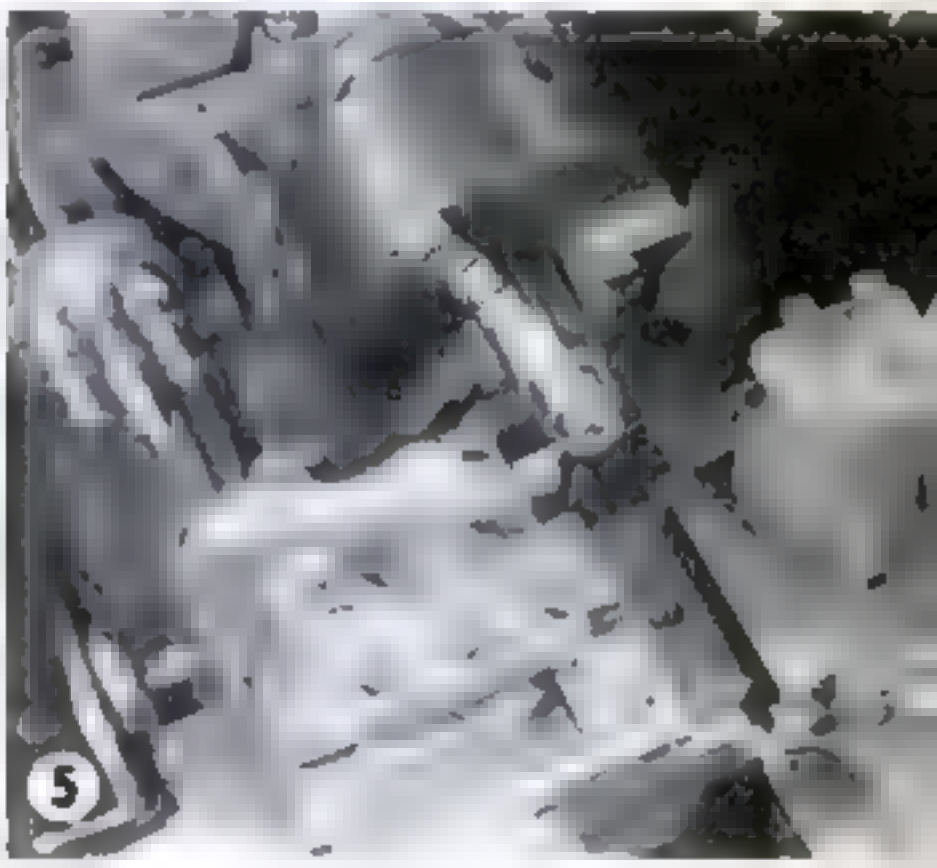
NOW that POPULAR SCIENCE has focused attention on the huge reservoir of skillful mechanics and excellent small machine tools available for war production in the home workshops of America (see P S M, March '42, p. 73, and April, p. 73), two questions are being asked by many readers. These are

1. Is there any way I can get a contract or subcontract immediately, by my own efforts, without waiting for Government action?

2. If I do obtain some war work, what are the best ways of tooling up my shop for maximum production?

The first question is far from easy to answer at this stage when the Government is concentrating so large a part of its efforts on the wholesale conversion of industrial facilities to war work and other gigantic production problems. The best I can do is to summarize my own experiences and those





Photos above show sequent operat ors with a car- r age turret: centerdri ing, turning to diameter, turn ng front end, and thread cutting. At eft chamfering back and cutt ng off. Below, another sma l bench lathe converted into a screw machine by the addition of carr age and ta lstock turrets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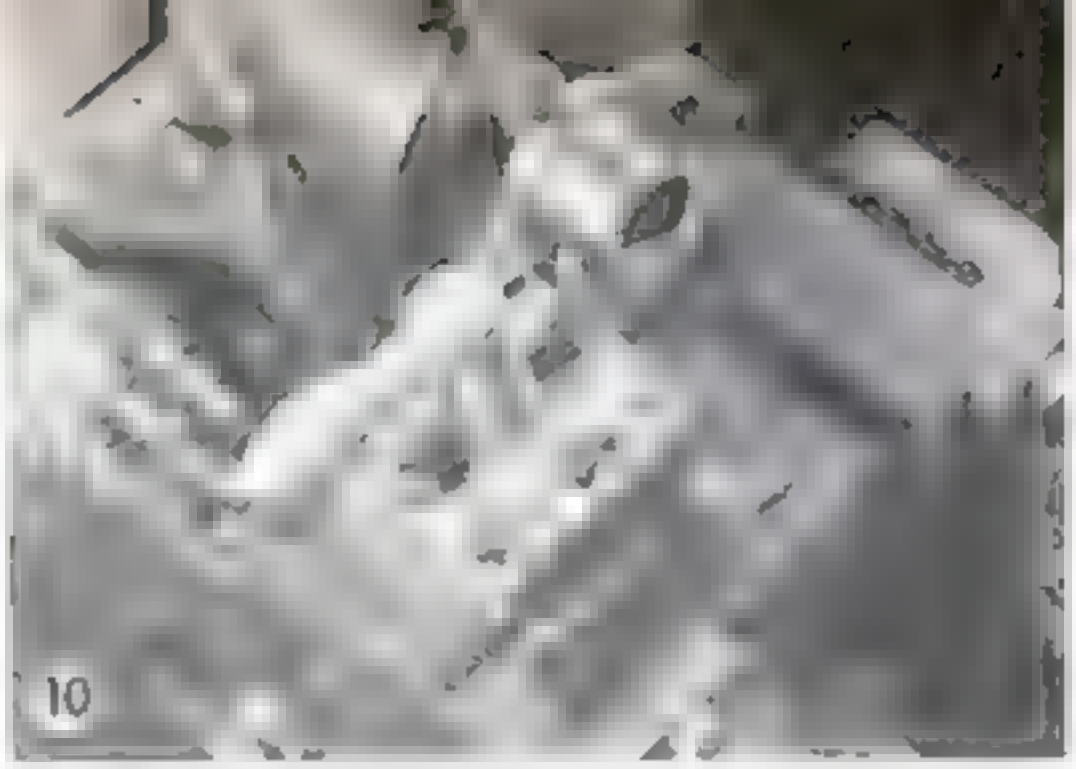
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of some of my acquaintances who are already using their home workshops for the manufacture of war materials. They have had no difficulty in getting work and have invariably been surprised at the coöperation they have received.

As my home is not far from a highly industrial section, I was aware that there were opportunities for the owner of a well-equipped small shop who wished to obtain contracts. However, I did not realize the variety of the work available until the old OPM (now reorganized under the War Production Board), in coöperation with the Army, Navy, and Maritime Commission, sent out three trains, which made a 33-day tour of the country to dramatize the needs of the Government in defense mobilization. More than 21,000 war items were displayed in these red, white, and blue Defense Specials, ranging from a 12-cent wire brush to flame-throwing equipment and bombs for parachute troops.

Along with a regiment of small business men, I visited one of these trains. Car 1 featured the exhibits of the Army Ordnance Department, with many types of gun parts. Car 2 contained the exhibit of the Army Air Corps. Hundreds of airplane and motor parts of stainless steel and aluminum, propellers, small nuts, bolts, washers, and other items produced on screw machines were on display.

Car 3, for the Army Corps of Engineers, the Signal Corps, and the Chemical Warfare Service, exhibited a wide variety of equipment, including complete radio sets for use in airplanes, tanks, and jeep cars, field radios with hand generators, and so-called "walkie-talkies."

In Car 4 was shown equipment of the Army Quartermaster Corps, the Maritime Commission, and the Navy Bureau of Ships. Car 5 displayed


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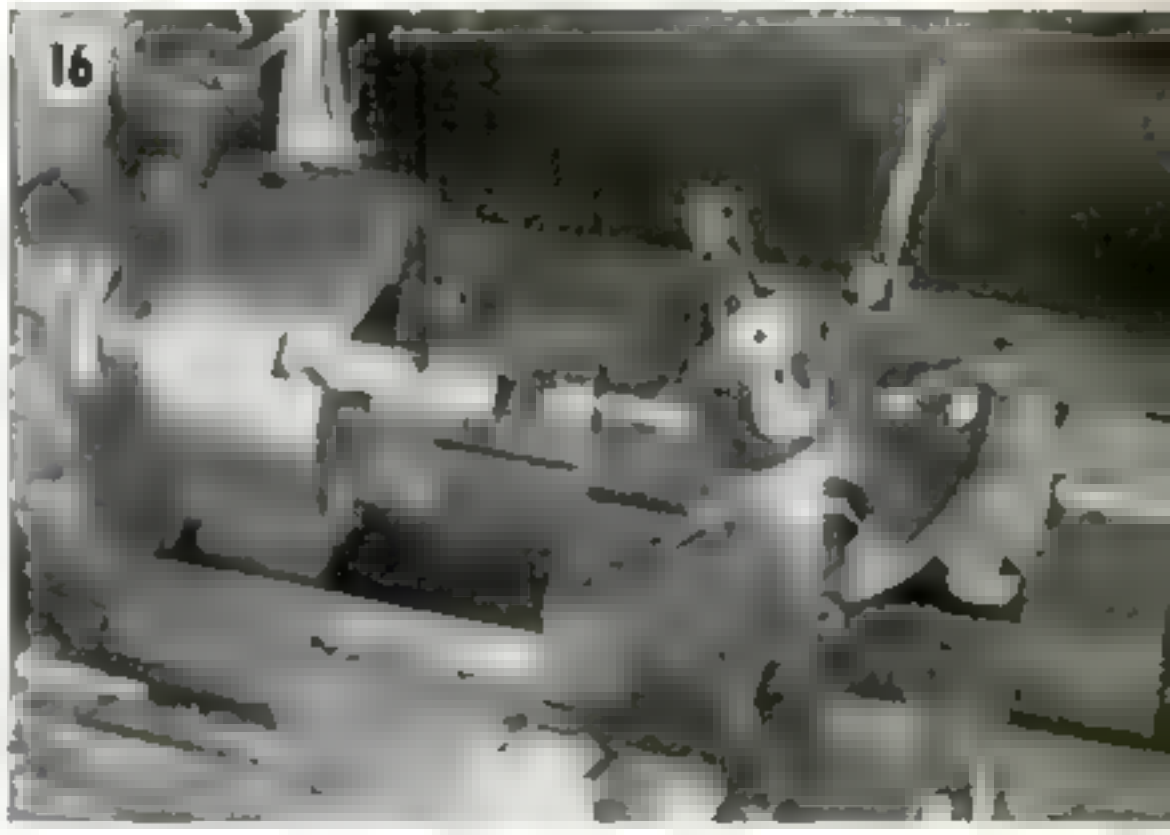
12

items of the Navy Bureau of Aeronautics, the Bureau of Ordnance, Bureau of Supplies and Accounts, Bureau of Navigation, and the Marine Corps. Officers were present to explain their industrial needs, which included such commonplace items as tinners' shears, calipers, hammers, steel tapes, hack saws, and hundreds of other small items as well as larger ones.

Contracts for much of this work can be had, I discovered, by applying at the local offices of the Government production agencies, or through correspondence with procurement offices of the Army, Navy, Maritime Commission, or Treasury Department in Washington, or the regional Quartermaster Corps offices throughout the country. These departments warn manufacturers that the defense program is "no WPA" and they should not simply wait for the Government or some prime contractor to hand them orders, but should go out to get them

Some small shop owners are needlessly frightened by the quantities required by various Government agencies, such as items to be made in 1,000 000 lots. In these cases home-shop owners usually can submit bids for smaller lots—10,000, 25,000, 50,000 of an article, and these offers will receive consideration

Some manufacturers feel it is best to go to Washington to obtain contracts. This is what one small-shop owner did after contacting the local office, where he was told the Government needed certain types of work that he could turn out. He saw the clerk at the information desk in the War Department Building, told her what he wanted, and she gave him a slip to the Quartermaster Corps. *(Continued)*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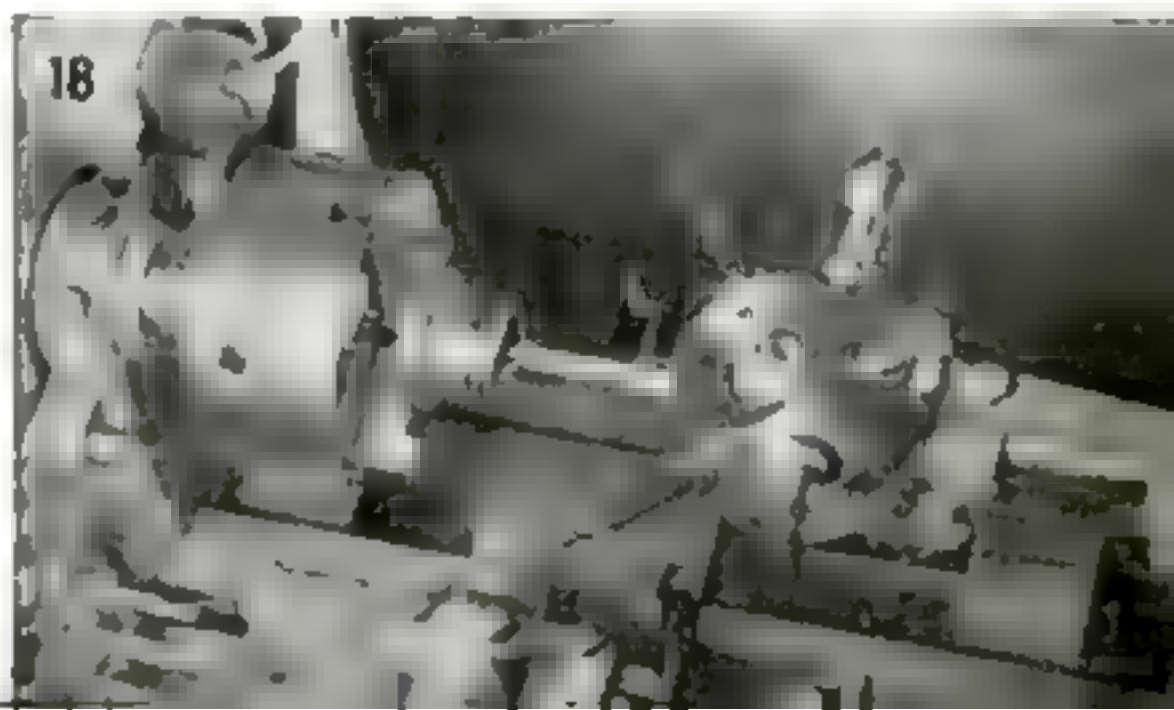
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At the Quartermaster's office they showed him plans and specifications of a large number of items. He selected a few that he could turn out with his equipment and submitted bids then and there. They inquired about his financial position and shop equipment and said they would let him know what he could make.

Within a week he received a long-distance call from Washington asking if he could make $23,000 worth of parts in 90 days. He told them he could guarantee delivery on only half that amount because of his limited facilities. He immediately got the order. There was no red tape, no embarrassing questions, and it was evident from the start that the Government was anxious to give out business to the small-shop owner and really wanted to help.

"Of course," this energetic mechanic said, "you can't sit still and wait for business. You've got to sell yourself and your facilities, and the Government will see that you get orders to fit your requirements."

For the man who has developed a small home shop as a hobby and has spare time on his hands that he would like to use in doing his bit for the defense program, taking subcontracts will probably work out best. Many large firms that are unable to expand their facilities fast enough have

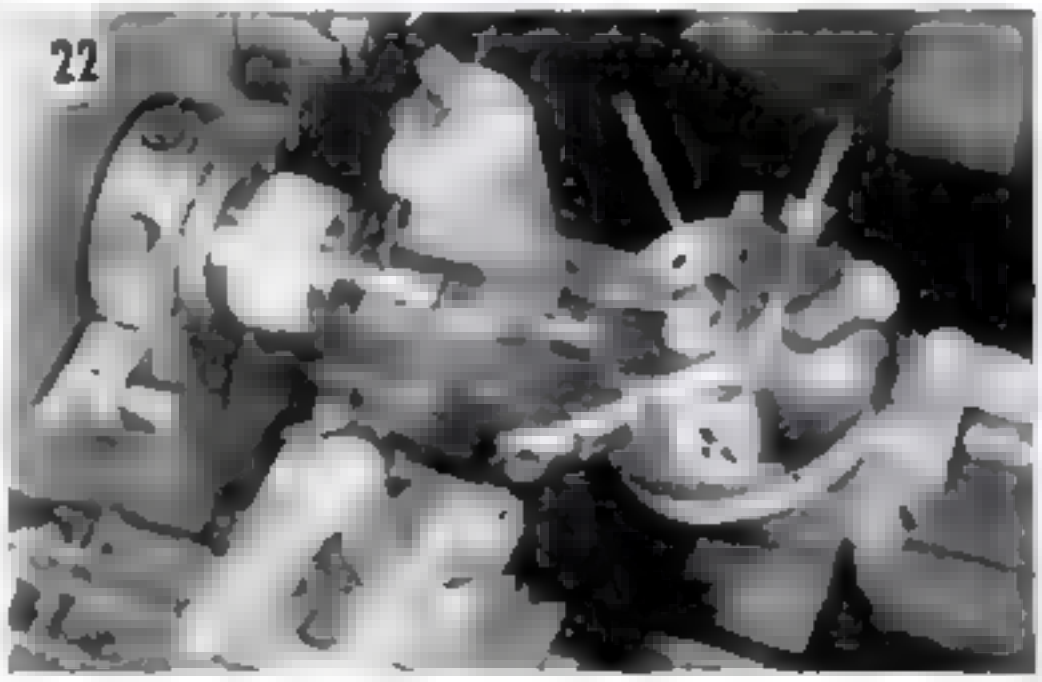
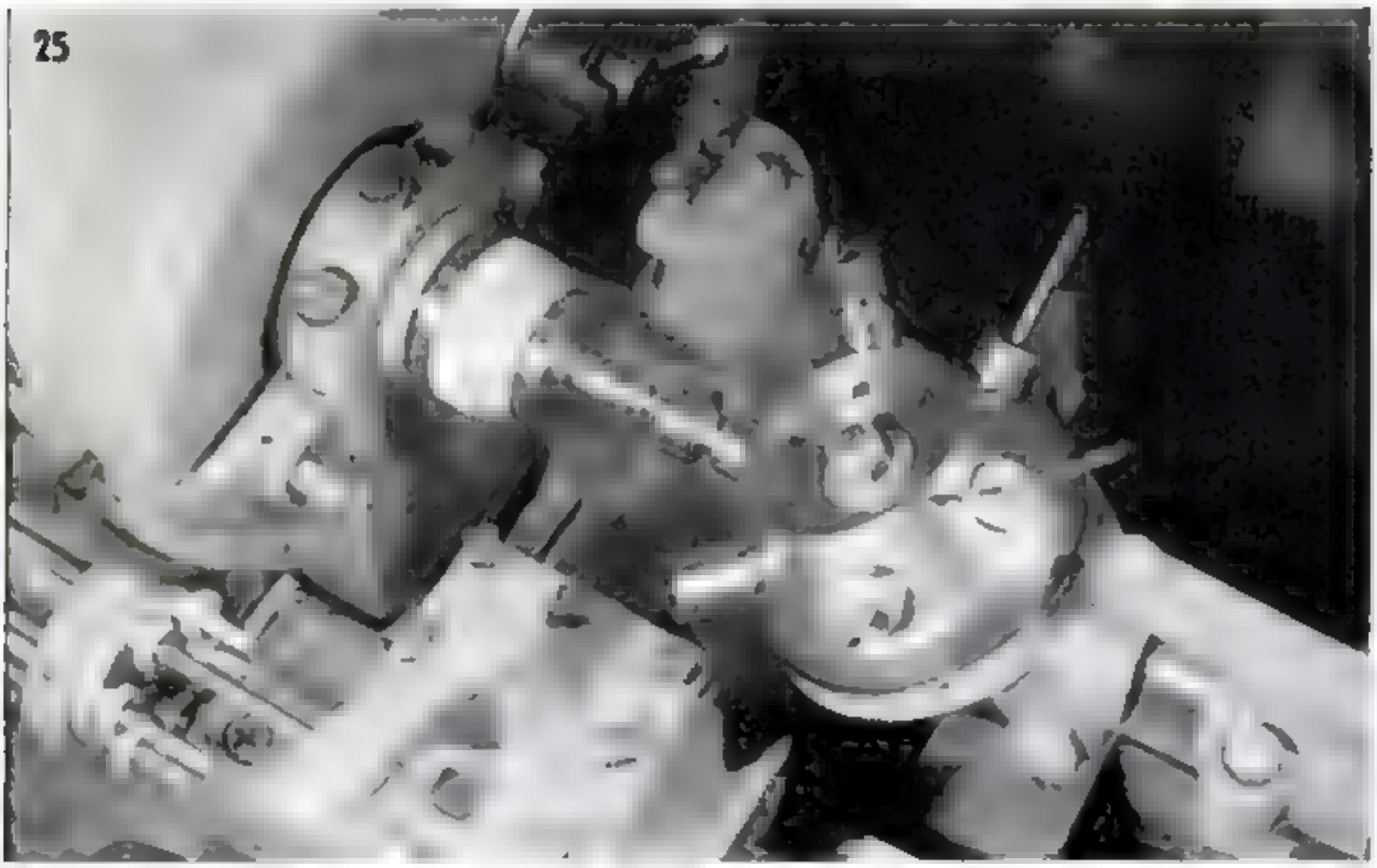
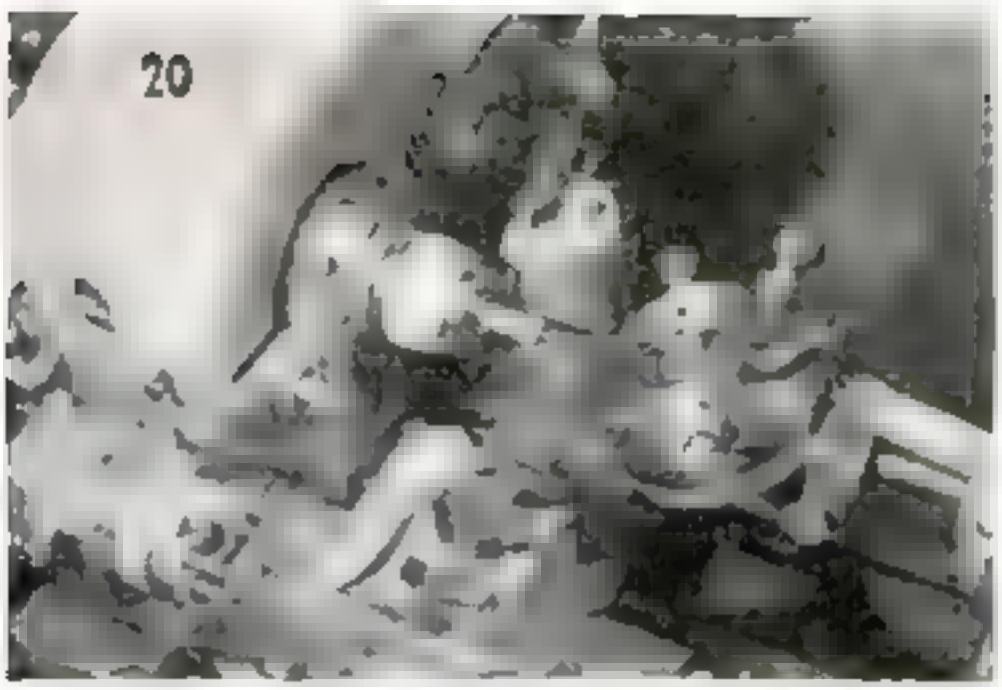
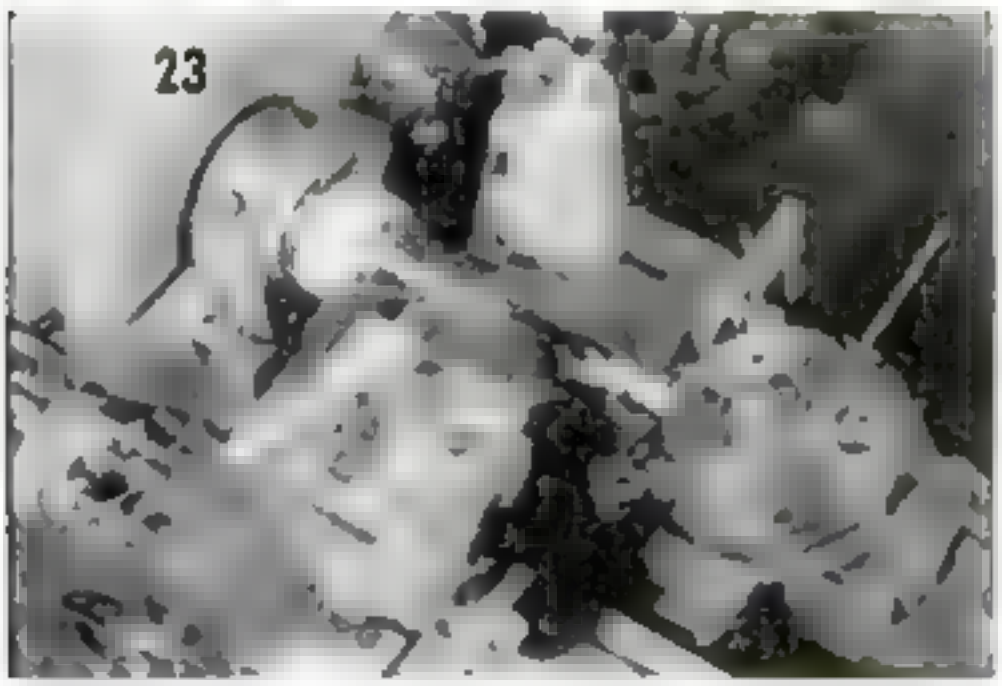
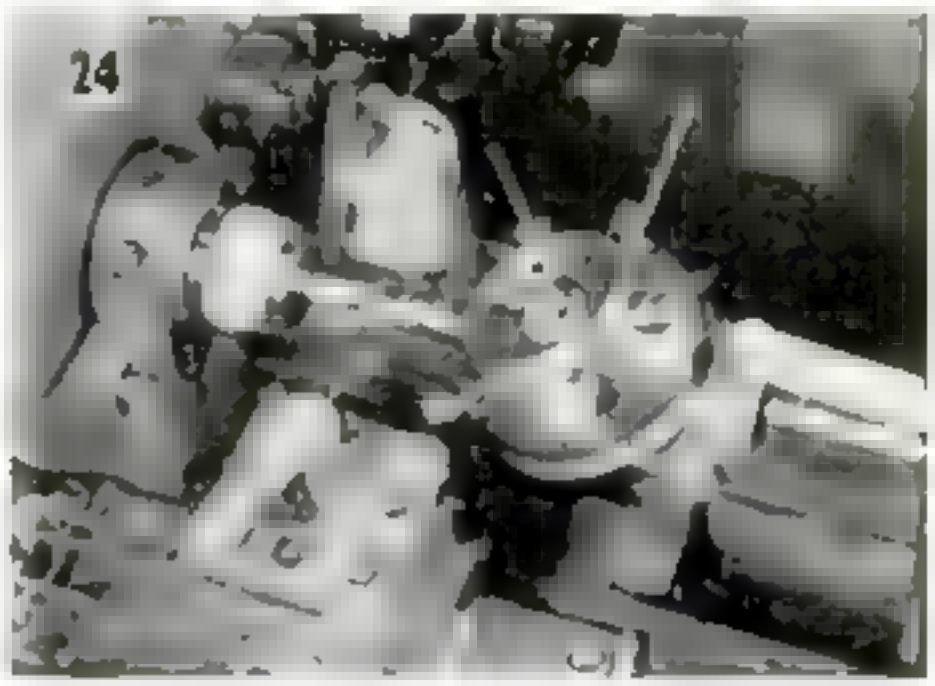


Figure 19, above, shows how work is mounted against a stop in the tailstock turret; 20, centerdrilling; 21, drilling 1" deep; 22, tapping 10-24; 23, turning to size; 24, reducing diameter with a hollow mill . . .

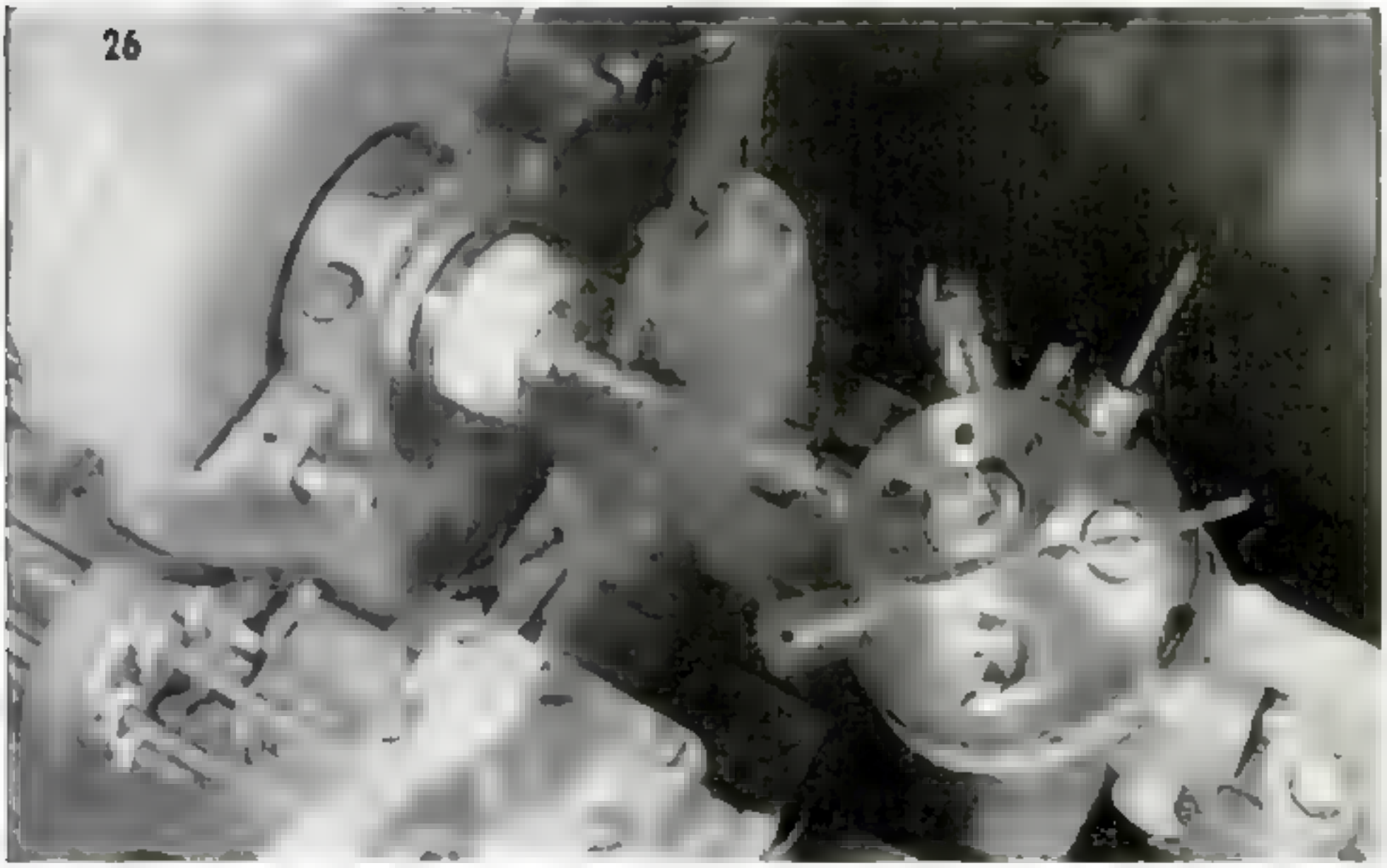




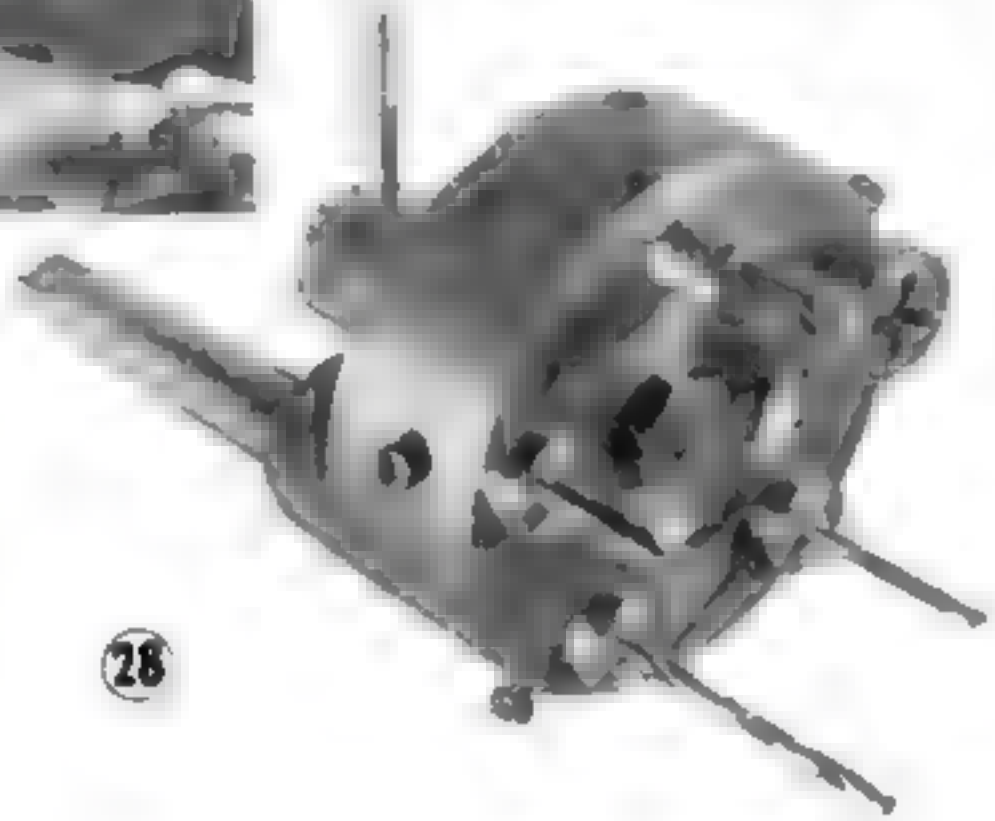




In Fig. 25 (bottom of facing page) a die is brought up to cut ¼"-28 threads on the work. The tailstock turret is then backed off and the back tool post is brought forward to cut off the piece, as shown below



This homemade tailstock turret was used to turn out 4,500 small parts for one type of 50-caliber gun. Here it is shown tooled up to drill, tap, turn down, and thread work chucked in the lathe, each tool being aligned in turn by an indexing pin. A knurling tool (at left) also may be used



turned to subcontracting and have organized their own "bits and pieces" program. Some of these firms have sent out men for miles around to locate small shops capable of helping them. As a rule, the machine-tool dealer, who handles shop equipment, can furnish the names of these men, and a phone call will bring one to your shop, where he can list your equipment and facilities.

Some of the large firms have a dozen or more purchasing agents on their staff who are constantly searching for skilled shop owners. A personal call on one of these agents will establish a contact, and the chances are he will pull out a blueprint of some small part and let you take it along so you can try making a few and submit a bid, or he may set the price for you and offer helpful suggestions as to how the work can be turned out with the equipment you have.

Many of these orders will warrant the purchase of special equipment, if it is needed, and in this case he will see to it that the Government issues you a priority rating to enable you to purchase the tools and equipment to do the job. In most cases the manufacturer will furnish the material from which the parts are to be made, and in some instances will also furnish special tools or other equipment.

Now, to turn to the second question, it is not hard to tool up a home shop for rapid production work. The drill press can be easily converted into a tapping machine for threading a large number of holes, or it can be used for surface grinding, with proper wheels and fixtures, and also for light milling operations where high speed is necessary. The shaper and milling machine can also be converted into production tools with the addition of jigs and fixtures, and the lathe has almost no end of possibilities for production work.

Most lathe manufacturers make lever-type collet chuck attachments, taper attachments, and carriage and tailstock turrets as accessories for their lathes. With this equipment, as shown in Figs. 1 and 8 and in some of the other photos, the average small lathe can readily be converted into a fine little hand screw machine capable of rapidly producing duplicate parts from bar stock.

As shown in the series of photos marked Figs. 2 to 7, and also in Figs. 9 to 12, the addition of a simple carriage turret will enable a variety of operations to be performed on small castings or other work held in the ordinary lathe chuck. This attachment consists of a double-tool cross slide, four-way tool-post turret, and back-slide tool post. It replaces the standard compound-rest assembly and adapts the turret to the carriage cross-slide dovetails. A lock handle releases the turret head so it may be rotated quickly to any one of four positions, which are automatically indexed.

The back-slide tool post permits a fifth operation, usually cutting off. The five cutting operations this attachment will perform, with its stops set to gauge the depths of cut, make this a valuable production tool for accurate duplicate work. Figure 9 shows a small pot casting being faced off. It is turned to size (Fig. 10), grooves are cut as in Fig. 11, and then the end is chamfered (Fig 12).

The tailstock turret attachment shown in Figs. 13 to 26 consists of the indexing head and an extra long feed ram with hand-lever control and depth-stop screws. The index-

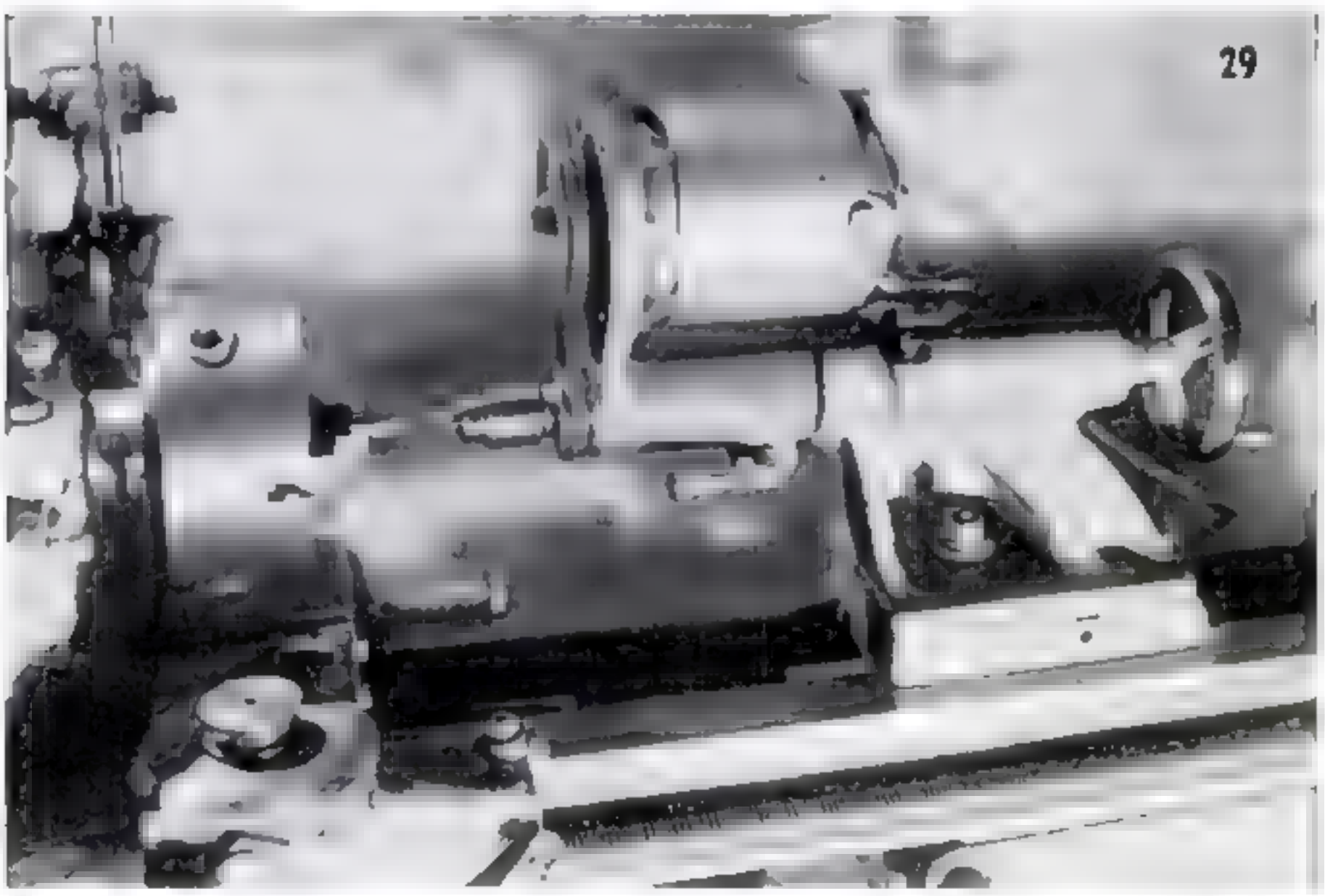
ing head has six ¾" holes for tool holders, permitting six additional operations. These are: Fig. 13, centerdrilling bottom of the casting; Fig. 14, drilling through the bottom; Fig. 15, spot-facing with a counterbore; Fig. 16, countersinking the hole; Fig. 17, tapping; Fig. 18, boring out the casting to 1¼" diameter.

With the addition of a lever-type collet attachment, as shown in Figs. 19 to 26, the lathe is converted into a very practical hand screw machine capable of producing parts rapidly and accurately in large quantities. This lever-release collet attachment is the ideal chucking method for fast, accurate duplicate work on bar stock up to ⅛" in diameter. Work may be fed through the hollow torque tube of the lever-type attachment, chucked, machined, and released without stopping the lathe. This speeds production enormously and reduces labor as well.

For work that does not require a large number of operations, a homemade turret attachment of the type shown in Figs. 27 and 28 will work out well. The construction of this tailstock turret was described in a previous issue (P.S.M., June, '40, p. 188) and it has been used, in one instance, for the production of 4,500 small parts for a 50-caliber gun. These were turned out at the rate of 250 a day after the time-consuming job of tooling up had been accomplished. This is not high production as compared to screw machines, but at 28 cents each for the gun parts, the little attachment soon earned the cost of building it.

One important lesson learned in turning out this job was the necessity of using the proper cutting oil for tapping the small hole in this part. In attempting to tap this hole in the lathe at high speed, a number of taps were broken and many parts spoiled by torn threads until the right cutting oil was found. Lubricating oil was as useless as no oil at all, and a number of other oils were tried with no better results. Finally one similar to an animal lard oil was used. This allowed the tap to be driven through the hole at high speed, thus cutting clean and perfect threads in the hard steel parts.

The motor-driven tailstock drill shown in Fig. 29 is another homemade attachment built for the express purpose of drilling three No. 80 holes in the end of small parts. The ball-bearing motor is of the high-speed type, with pulleys arranged to drive the chuck arbor at the extreme speeds necessary for these fine drills. The tailstock was offset slightly to bring the drill point to the correct distance from the center of the work, and the chuck jaws were used for dividing—that is, for locating the three holes accurately. An article on the construction of this attachment is scheduled for a forthcoming issue of POPULAR SCIENCE.



A high-speed motor was mounted on a homemade tailstock attachment for drilling three radial holes in a small turning. Setting the tailstock over located these accurately with reference to the work center

IDEAS for HOME OWNERS

LAYING STRAIGHT EDGES in gardening and landscaping is conveniently done with the aid of two sturdy stakes and an antibacklash reel that holds a strong 50′ line taut. Sliding brackets on the stakes permit adjustment of the line to any height from the ground to the reel and adapt it to trimming hedges evenly as well as to edging borders, marking rows for planting, and laying out tennis courts and cement walks, driveways, and foundations. When a job is completed, the line reels in neatly for storing.

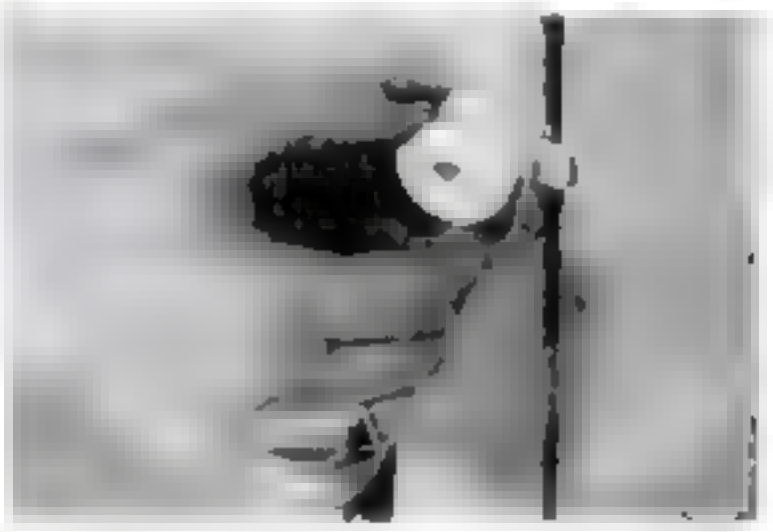
LINOLEUM IS PROTECTED from the underside by a special type of felt lining that has been put on the market. This new felt, impregnated with asphalt to guard against dampness, acts as a shock absorber under the linoleum, helping to silence the tread of feet, and also prevents any "bunching" of the floor covering that might be caused by heavy traffic. It makes an effective insulating material and can assist markedly in bringing about a reduction in the fuel bill. The felt comes in regulation carpet-size rolls of 50 lineal feet, 36″ wide, and can be cut easily for fitting with an ordinary linoleum knife. It is laid directly on the floor in the manner of carpet, and the linoleum is then laid over it in the usual way. This type of lining will be found especially beneficial where linoleum is used in hallways, in busy kitchens, and in playrooms, particularly those playrooms given over to the romping of children, and recreation rooms with cement floors.

PENETRATING INSTEAD OF COATING, a floor finish recently introduced is said to harden the wood for wear resistance and to require renewing less often because it permits the wood to share the wear with the finish. The liquid is transparent, tending to bring out natural grain as it soaks in, but may be combined with oil stains to produce darker effects. If it is used on old floors, earlier finishes must first be sanded off thoroughly.

No knife or screw driver is needed to attach this electric plug. Part the two wire ends without stripping the insulation, fit them into place, and simply twist on the cap

ELECTRIC APPLIANCE PLUGS, employing a forced-tooth principle of connection that makes it unnecessary to strip off wire insulation, are now made for use with flatirons, waffle irons, coffee brewers, toasters, sandwich grills, and the like. Assembly of the two-piece units is simplified by a cap that screws in place over the connection without the use of tools and presses eight brass teeth through the cord into contact with the wire. There are wells in the base for the safe tucking away of live ends. The same features are provided in companion wall-socket plugs, which have the additional advantage of a side outlet to prevent jerking on the cord when removing the plug from the socket. The plugs are available separately, or may be had together with an 8' heavy-duty cord.

PLASTIC SHATTER-LOCKS that are strong enough to insure privacy, yet can be broken quickly in an emergency, will be found useful for bathroom doors and the like, especially in homes where there are children who may lock themselves in or invalids subject to fainting spells. The metal catch is screwed on the jamb just above the regular lock, and the plastic knob is mounted on the door to fit into the slot when turned. Two extra plastic knobs are provided in each set for use as replacements should unexpected emergencies arise.

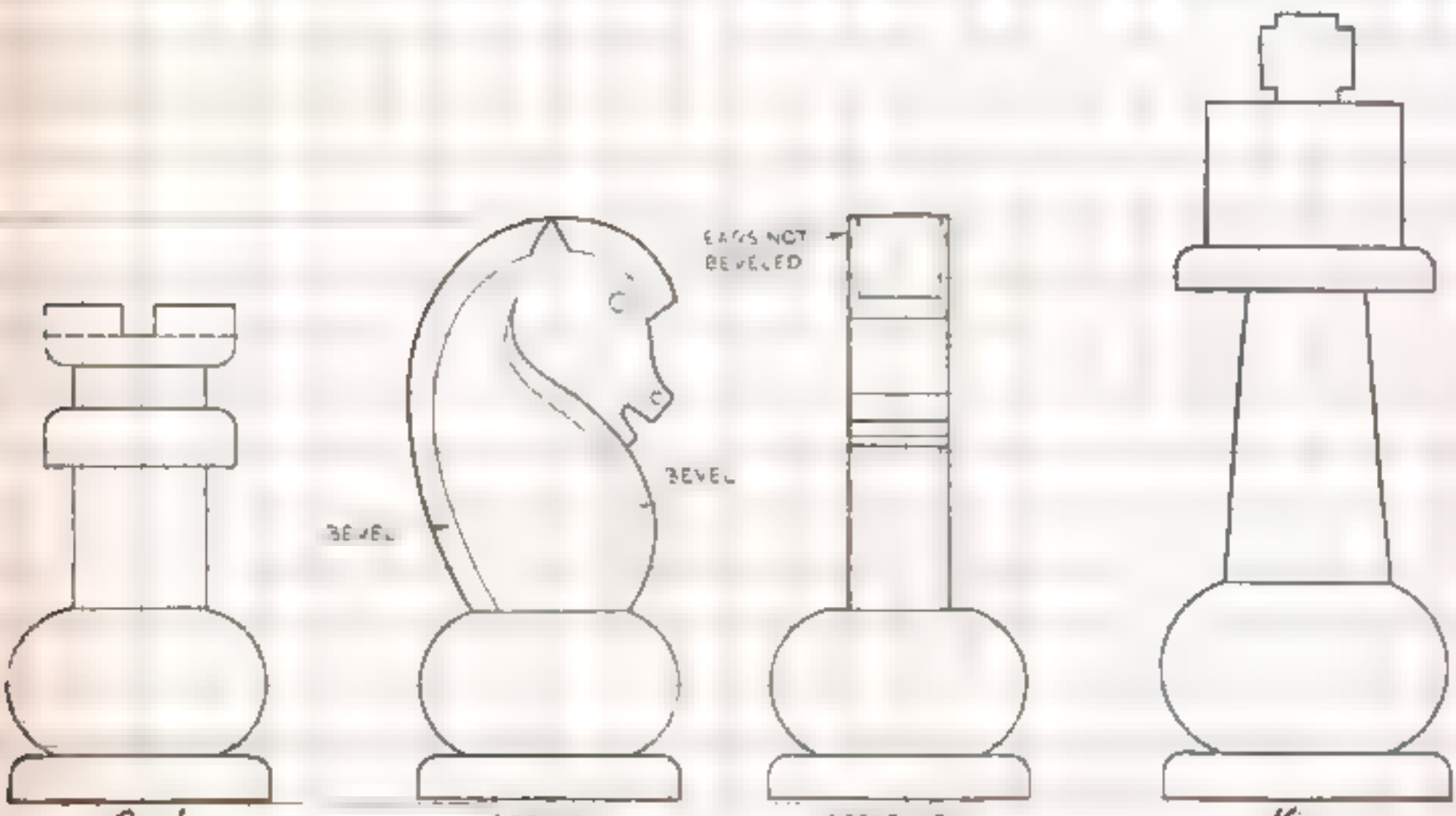


SLIDING-DOOR FRAMES designed for use with standard 1⅜" thick stock doors can be obtained ready for installation in the small apartment or home where floor and wall space is at a premium. The assembly is available only for doors 6' 8" high, but is offered in five widths from 2' to 3'. The frame fits within the wall itself. Hanging requires no metal channel, the rollers gliding instead along a groove in the wooden header. The frame and assembly equipment are supplied as a unit without the finish hardware and trim, these being left for separate selection to suit the room.

Above, sectional view of roller-and-groove assembly of the door at right. The sliding unit hangs by slotted metal brackets, one of which is pictured

MODERN Chessmen

DESIGNED BY JUAN OLIVER



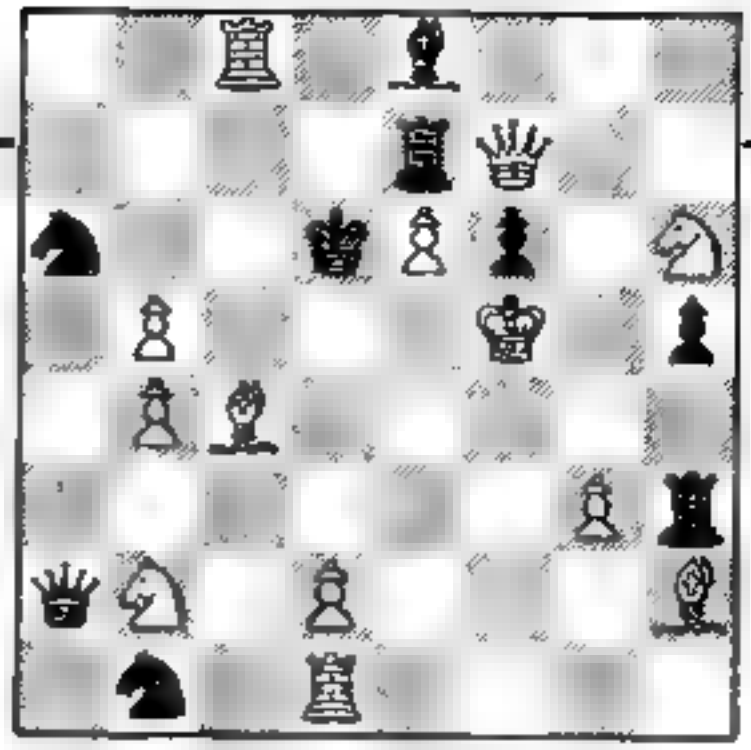
IN A WORLD at war, chess—the ancient game that is combat in miniature—still holds its own. British pilots awaiting an "alert" play it under the very wings of their fighting planes. Soldiers in barracks, sailors off watch, and workers resting from their labors on the production line find that this royal pastime stimulates their minds and relaxes taut nerves.

Although modern in style, these chessmen are not extreme; they are easily recognizable for what they are and therefore pleasant to play with. Only the most expensive commercial sets can match them in beauty, especially if plastic is the material used. You can make them in a few evenings at the lathe. If you don't play yourself, remember that a set will be a welcome gift to many a man in the service.

The pieces illustrated are of ivory and dark blue plastic, but any fine-grained hardwood such as boxwood, walnut, or maple can be used instead. The men can be made exactly the size of the drawings on this page, or the patterns can be reduced or enlarged by tracing them on smaller or larger squares. If you wish to have the pieces resemble orthodox chessmen still more, you can file the stepped turning on the head of the king to form the familiar cross, carve small scallops on the head of the queen, and slot that of the bishop.

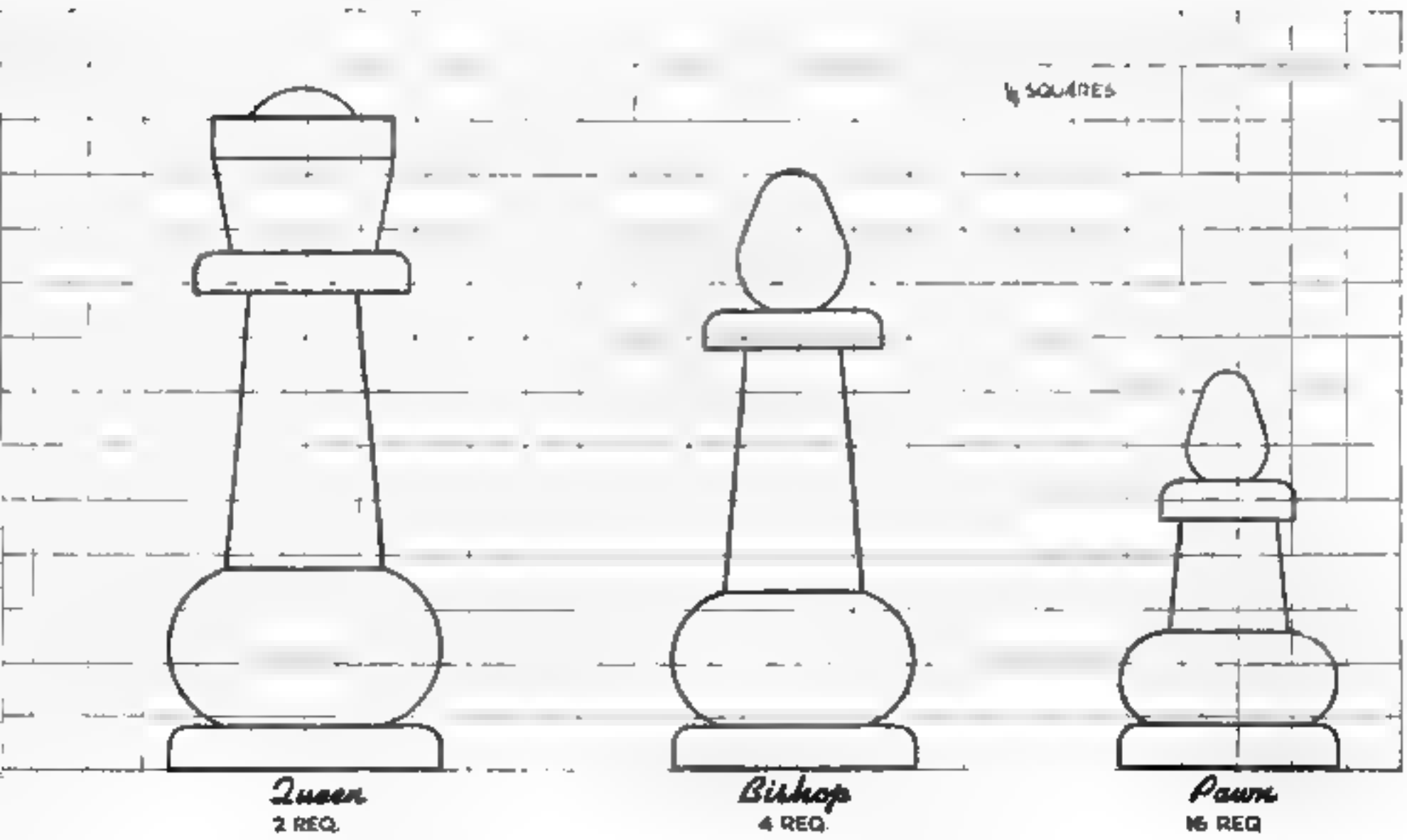
After sanding the pieces, if they are turned from wood, paint or stain half of them one color and leave the others natural or finish them in a contrasting color. Plastic must be buffed on cotton wheels.

BLACK—9 PIECES



WHITE—13 PIECES

CHESS wizards, attention! Can you solve this problem, which is also shown set up on the board on the facing page? White is to play and checkmate in two moves. The theme is to expose the white king to checks from every type of hostile man. The problem might well be called, "Into the Jaws of Death." Actually checks may come from a pawn, a bishop, the two knights, the two rooks, and the queen. Note, too, that black would be unable to check white anywhere if it were his turn to move first. The problem is by P. L. Rothenberg.

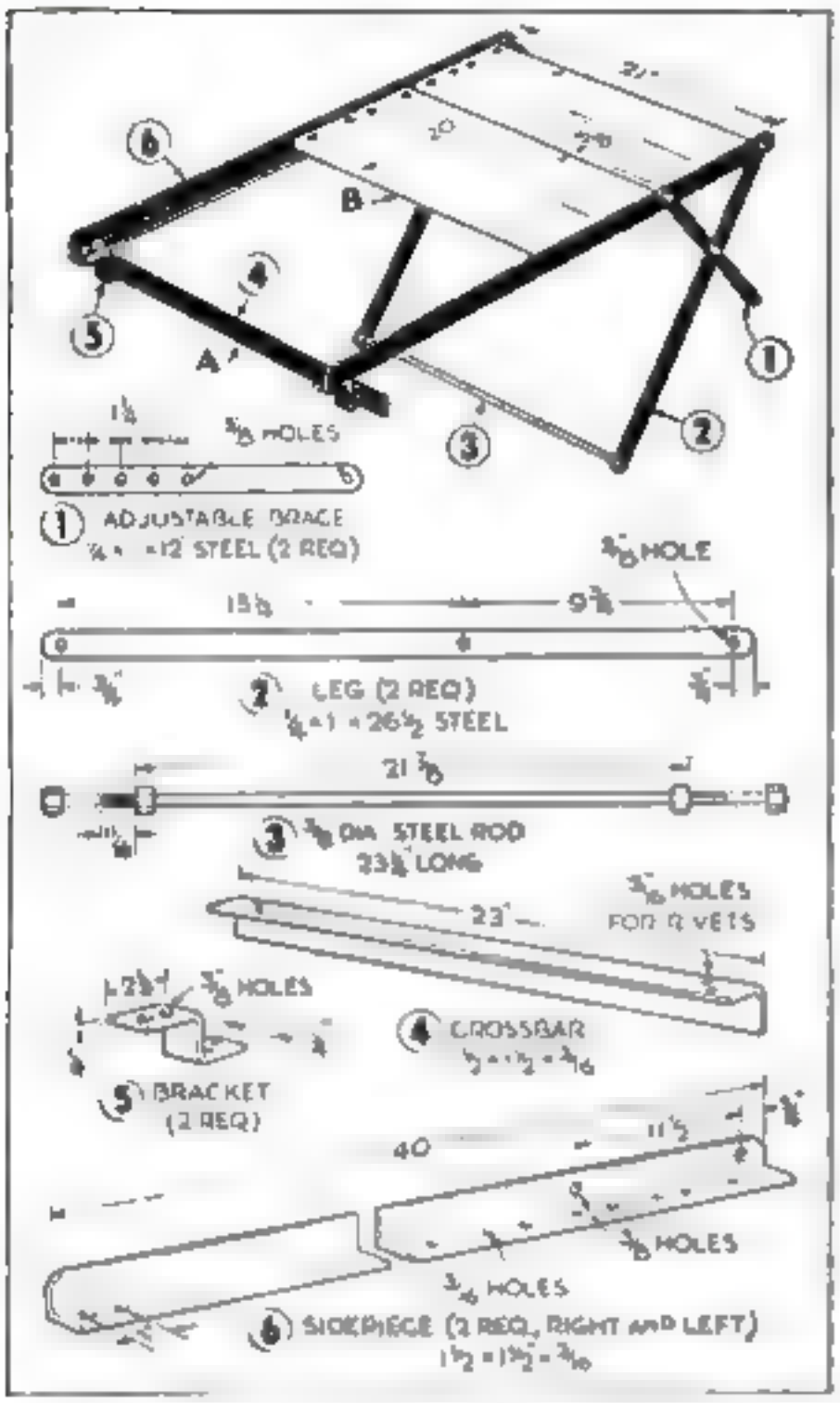


Queen
2 REQ.

Bishop
4 REQ.

Pawn
16 REQ.

Adjustable Platform for Painting and Cleaning Windows



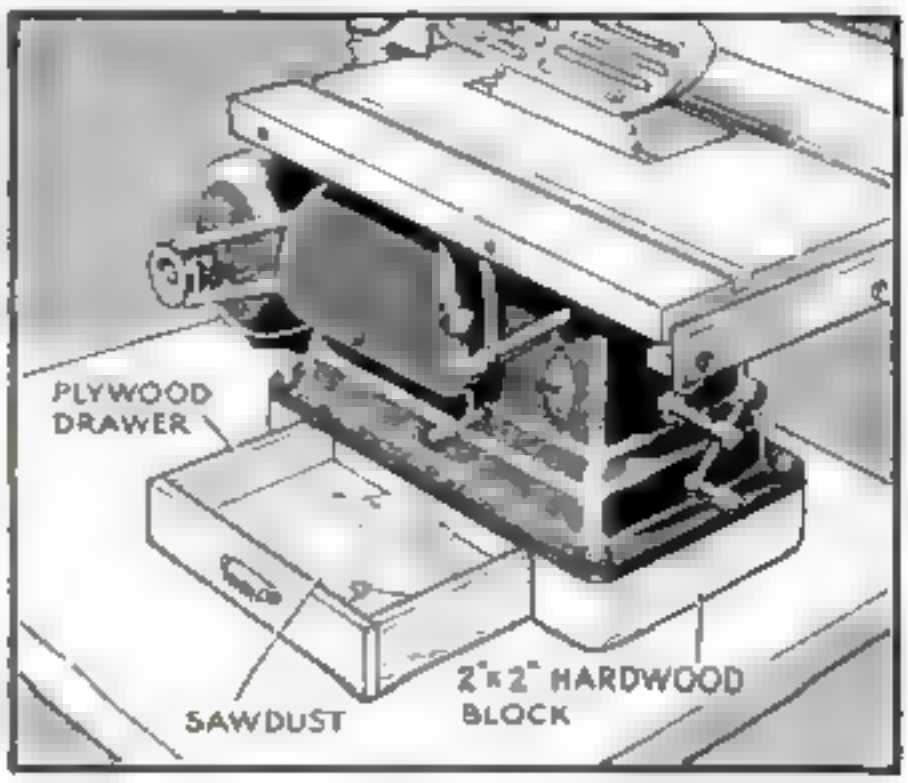
Anchored to the window ledge, this platform of steel and hardwood provides safety for workmen

WINDOW painting and cleaning platforms of the type illustrated have proved their value at Concordia Teachers College, Seward, Nebr., where they have been used on nine buildings for the past seven years.

The framework is of steel fastened with ⅜" bolts, and platform *B* is of hardwood fastened to the sidepieces with 3/16" roundhead stove bolts. The crossbar marked *A* hooks under the projecting ledge of the window sill on the inside of the building. Piece *A* is riveted to the brackets with 3/16" rivets. It is important that the legs, marked No. 2, rest firmly against the outside wall. A guard rail could, of course, be added if thought necessary.—RUDOLPH BERNING.

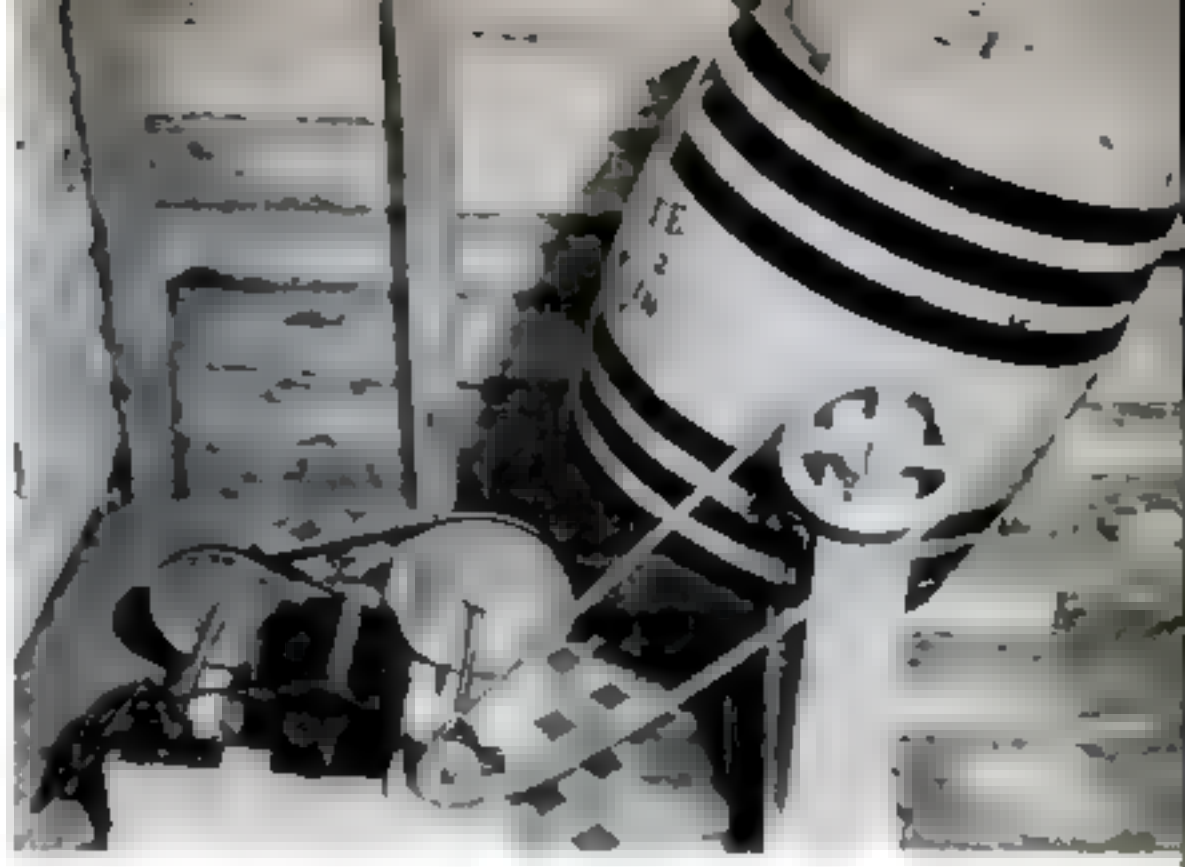
Small Drawer Under Bench Saw Aids in Removing Sawdust

SOME bench-type circular saws are so constructed that sawdust falls into the hollow base casting, from which it is hard to remove except with some kind of suction device. This nuisance can be eliminated by raising the saw base on 2" by 2" hardwood blocks. The mounting bolts should pass through these blocks into the bench top. A plywood strip is used to close the opening at one end, and a plywood drawer is then built to fit between the blocks. A handle may be attached, provided that it will not interfere with any other equipment used on the bench.—THOMAS WAYLING.

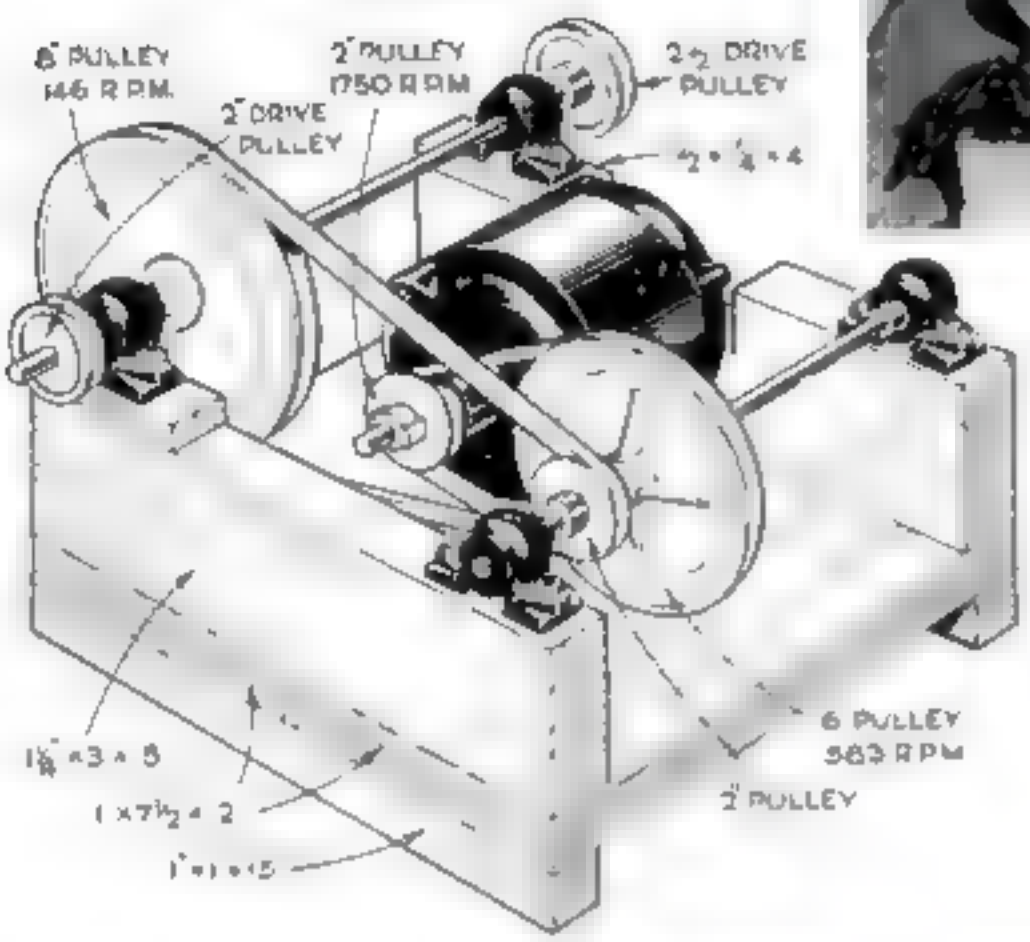


Speed-Reducing Pulley System

FOR HOUSEHOLD MACHINES



The speed reducer operating a barrel churn. Extra pulleys of any required size can be added to either shaft for driving a grinder, feed mill, freezer, or other machine



FOR daily tasks around the farmhouse or country place, a ¼-h.p. motor can be rigged up as shown with a system of speed-reducing pulleys to operate a hand churn and other machinery. The one illustrated was set up on a wooden base and consists of six die-cast pulleys, three 2" in diameter, one 2½", one 6", and one 8"; three ½" V-belts, 24", 36", and 58" in length; four brass-bushed pillow blocks, and two 15" shafts of ½" diameter cold-rolled steel. With a 1,750-r.p.m motor, this will give additional speeds of 583 r.p.m. and 146 r.p.m. Should the base not prove heavy enough to keep the drive belt taut, rubber pads under the cleats will help to hold it.—W. EDWARD WHITE.

Dagger Clothes Hook Seems to Pin Garment to Wall

WHAT boy will forget to put away his clothing if he can use this novel hanger? The garment actually depends from a wire hook, but to all appearances is skewered to the wall by a dagger.

Shape the blade from a ⅞" by 5½" tapering strip of tin-can stock to a V-section. Notch the top down for about ⅝", bend the two pieces at right angles, and solder a small washer across both. A screw through this fastens the blade to the handle and guard, which may be cut from contrasting woods such as walnut and maple, and carved or filed to any shape the maker pleases. Scour the blade bright with steel wool, and give all parts two coats of clear lacquer.

Make the spring hook from a single 16" length of No. 14 spring-brass wire or from a heavy clock spring. Solder it to the blade before screwing on the handle. Two brass washers are soldered on for the mounting screws. The hollow blade should conceal the hook when no garment is on it.—W. A. CONWAY.

Getting Top Speed

FROM YOUR OUTBOARD MOTOR

By BRUCE and WILLARD CRANDALL

HOW fast an outboard boat will travel with a given motor depends, of course, on the lines of the boat—that is, on the shape of the bottom. A boat designed only for slow speed is known as a displacement boat regardless of whether it has a round, flat, or V-bottom. Even when making the greatest speed for which it is designed, such a boat still displaces the same amount of water it does at slower speeds or at rest. Power above that for which the boat was designed results principally in increasing the size of the wake which the boat throws, with very little, if any, increase in speed. The bow may be forced up and the stern down, making the boat ride at a bad angle.

The fastest and most efficient displacement boats are those which are very long in proportion to their weight. They are usually at a disadvantage from the standpoint of stability and seaworthiness, however, and

therefore displacement boats are rarely designed primarily for speed.

A boat that climbs bodily out of the water and slides along the top under the application of power is called a hydroplane. An outboard boat designed as a hydroplane acts as a displacement boat up to about ten miles an hour. At that speed the bow begins to rise out of the water, as shown in the accompanying diagram. If sufficient power is then applied, the whole boat rises slowly out of the water, gradually increasing its speed. When the stern comes practically to the surface, the bow drops somewhat, the boat returns to a more level keel, and a full planing position is attained, usually at about 20 to 22 m p h.

The ease with which a boat attains planing speed depends on the total weight in relation to engine horsepower, on the design of the hull, and on weight distribution. Some hydroplane hulls are designed to attain the highest possible speeds, some for easy planing, and some for safety at full speed and ability to ride rough water. Others offer a compromise of all these characteristics. Still others are designed as combination hydroplane and displacement boats. The round-bottom runabouts are the most successful of the last type.

The table at the end of this article shows the approximate top speeds that should be attained with various loading and power combinations by outboard boats for which plans have appeared in POPULAR SCIENCE MONTHLY. These figures were reached by both calculation and actual testing. The weights are assumed to be those recommended in the instructions for building the boats, and 150 lbs. is allowed for each person carried. It is also assumed that the propeller is approximately correct for the hull.

In actual practice there may be considerable deviation from the values given in the table because of differences in actual horsepower of individual motors, in the weights of boats and passengers, and in propeller efficiencies. The table is least accurate for speeds from 10 to 20 m p.h. The first three boats listed are displacement boats; the fourth is a combination displacement boat and hydroplane, and the last three are stepless hydroplanes. When a space is left blank, it is because the boat would be either

PLANING WITH AN OUTBOARD HYDROPLANE. Top, as power is applied, the bow rises slightly and the hull acts as a displacement boat. Center, under full power, the hull is rising out of the water. Bottom, the full planing position, the stern rises higher at top speed

unsafe or very inefficient with an engine of the corresponding horsepower.

If you have built one of these boats, you will find it interesting and perhaps profitable to check your speed with that of the table by timing your run over a measured course. If your boat does not come up to the speed given in the table, it is most likely because (1) the total weight carried is greater than that used in calculating the table; (2) the motor does not quite develop its rated power; (3) the motor angle and weight distribution are not adjusted for best speed; (4) the propeller has been thrown out of balance by obstructions hit in the past, or is not exactly suited to the boat or the weight carried; or (5) the table is slightly inaccurate for that particular speed.

Weight distribution is a very important factor influencing the speed of both hydroplanes and displacement boats. The best distribution in a given boat will vary with the amount of power applied, and experimentation is always necessary to get the best results. Displacement boats are usually most efficient when running on an even keel; this is the reason their speed with only one person aboard may be increased as much as 4 m.p.h. by remote-control steering in place of ordinary back-seat operation.

The speed of a hydroplane is also greatly affected by weight distribution, though in a different manner. While the boat is beginning to plane, the passengers may have to move forward, but after planing speed is reached, the boat will go faster with the weight farther aft. The best weight distribution for a stepless hydroplane may easily be found by moving the weight aft, while the boat is running at full speed in smooth water, until a galloping motion begins. The most efficient distribution at that speed is with the weight as far aft as it can be placed without causing galloping. Remember, though, that a bad motor angle or bottom lines may also cause galloping.

In general, the correct motor angle is one at which the cavitation plate of the motor is parallel to the surface of the water at full speed, but some improvement in speed can nearly always be made by experimenting.

The propeller that the factory furnishes with a motor is the correct size only for the average boat for which the motor is designed. If the boat is a larger and heavier one, such as an outboard cruiser, or carries a heavier load than is usual, a propeller with larger area and less pitch will be more efficient. If the boat is lighter and faster than the average, as a small stepless hydroplane might be, it may require a propeller of greater pitch and possibly less area. A propeller that will make a hydroplane carry a heavy load effectively will be quite different from one that will give the highest speed with a light load.

SPEED TABLE FOR POPULAR SCIENCE BOATS

Horsepower Rating [National Outboard [illegible]	SECTIONAL ROWBOAT AND SAILING DINGHY		CAR-TOP BOAT*			OUTBOARD CABIN CRUISER			FAMILY RUNABOUT			[illegible] OUTBOARD BOAT			SPORT RUN-ABOUT		RACING RUN-ABOUT	
Passengers	1	2	1	2	3	1	2	3	1	2	3	1	2	3	1	2	1	2
.5	6.1	5.0	6.1	5.0	4.6													
1.1	8.0	6.7	8.4	6.9	6.0				7.4	6.7	6.0							
2.0	8.9	8.1	10.1	8.8	7.5	6.4	6.0	5.6	9.2	8.4	7.5							
2.5			11.9	9.4	8.2	6.8	6.4	6.0	9.9	9.0	8.2	9.9	9.0	8.0				
3.3			12.4	10.6	9.3	7.5	7.0	6.5	11.0	10.1	9.3	11.0	10.1	8.8	18.7			
5.0						8.5	8.1	7.6	13.2	11.9	10.6	16.1	12.9	10.5	24.3			
5.4						8.7	8.3	7.8	13.8	12.4	11.0	22.2	15.8	11.3	25.1	16.5		
8.5	MILES					9.7	9.3	8.8	18.5	15.0	13.5	27.6	23.5	19.1	30.0	24.3		
9.7	PER					10.0	9.6	9.1	22.3	16.8	14.3	29.7	25.1	21.6	31.5	26.1	25.8	22.0
16.0			HOUR						31.4	26.1	19.5	36.0	31.5	27.9			32.3	28.5
17.6									32.5	28.7	24.1						33.4	29.5
22.0									36.2	32.0	29.1						37.2	32.9
23.5									37.4	33.0	30.0						38.4	34.0
33.4									41.8	38.6	35.1						43.0	39.7

*Plans for this boat, the next in our series of small craft, will appear in a two-part article starting next month.

FIELD SHOWER BATH

Army Medical Battalion Makes Its Own from Junk Materials

By LIEUT. COL. F. T. CHAMBERLIN
U. S. Army Medical Corps

NEXT to food, about the most important thing in the field, to the million or more men who have been mobilized in the United States Army in the past year, is a good bath after a heavy day in the dust. We of the 45th Medical Battalion of the Third Armored Division have solved that problem satisfactorily after a profitable tour of junk yards near our camp.

There is nothing fancy about the equipment, but it works as well as one could wish, for giving showers to a large number of men in a short time. From the standpoint of portability, it comes very near to being the last word. It can be unpacked, assembled, and started in four or five minutes and, after use by the battalion, can be repacked in only three minutes. It occupies a surprisingly small space when in transport. Other outfits in the Army may find our design equally useful.

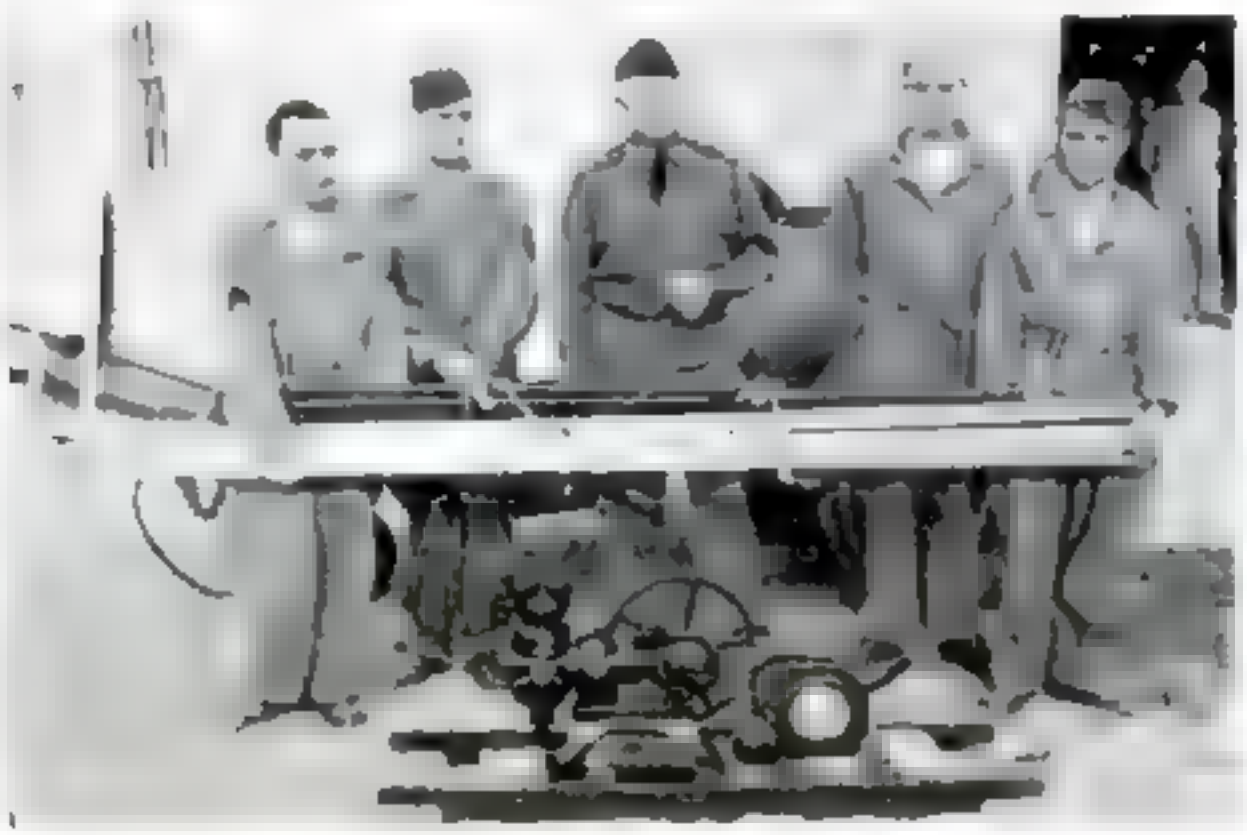
With some essential changes to meet individual needs, the plans may be adapted for defense workers where there is a housing shortage, for harvest workers, at camps for migrants and trailer and auto camps, and in farm homes without electric power.

New equipment can be utilized, but with no money in a nonexistent organization fund we relied on a much-dilapidated force pump, a ⅓-h.p., single-cylinder, 4-cycle motor which had served its best days on somebody's washing machine, several pieces of secondhand ¾" pipe, a number of pipe nipples, tees, and caps, a couple of sections of old garden hose, and several pieces of old lumber.

The pump and motor were pulled to pieces, and new parts, some purchased and others made on the spot, were substituted for those that were beyond redemption. Reassembled, the machines were painted, mounted on a homemade "litter" for easy handling, and tested. They functioned like new.

The ¾" pipe was cut into sections 2' long and joined end to end with the tees. Pipe nipples were inserted in the remaining openings of the tees. Pipe caps, each of which had been drilled with ten 1/16" holes, were screwed on the nipples. The 1/16" holes through the rather heavy metal at the end of the caps proved to be just the

Set up for operation in a maximum of five minutes, the shower above serves these Army men. Below, packed compactly for transportation



right size to throw jets of water suitable for a shower of this kind.

Other parts of the equipment were more easily constructed. They consisted of three pairs of folding supports made of old lumber and bolted at one end in the form of shears, two 15' lengths of garden hose and unions to reach to the force pump and water supply, and duckboards to keep the men's feet out of the mud. Water was drawn from a 250-gallon Army water cart hauled to the battalion area where the apparatus was set up, but we can, if necessary, put the hose directly in a stream and pump the water from there. Our pump throws 500 gallons an hour.

Although effective, the shower is often a cold one. We have under construction now a heating coil, also being built of scrap pipe. This pipe is coiled in several turns and will be placed in a so-called "GI" can of water under which a fire will be built. The water drawn through the coil will be lukewarm.

ABRASIVE PAPERS

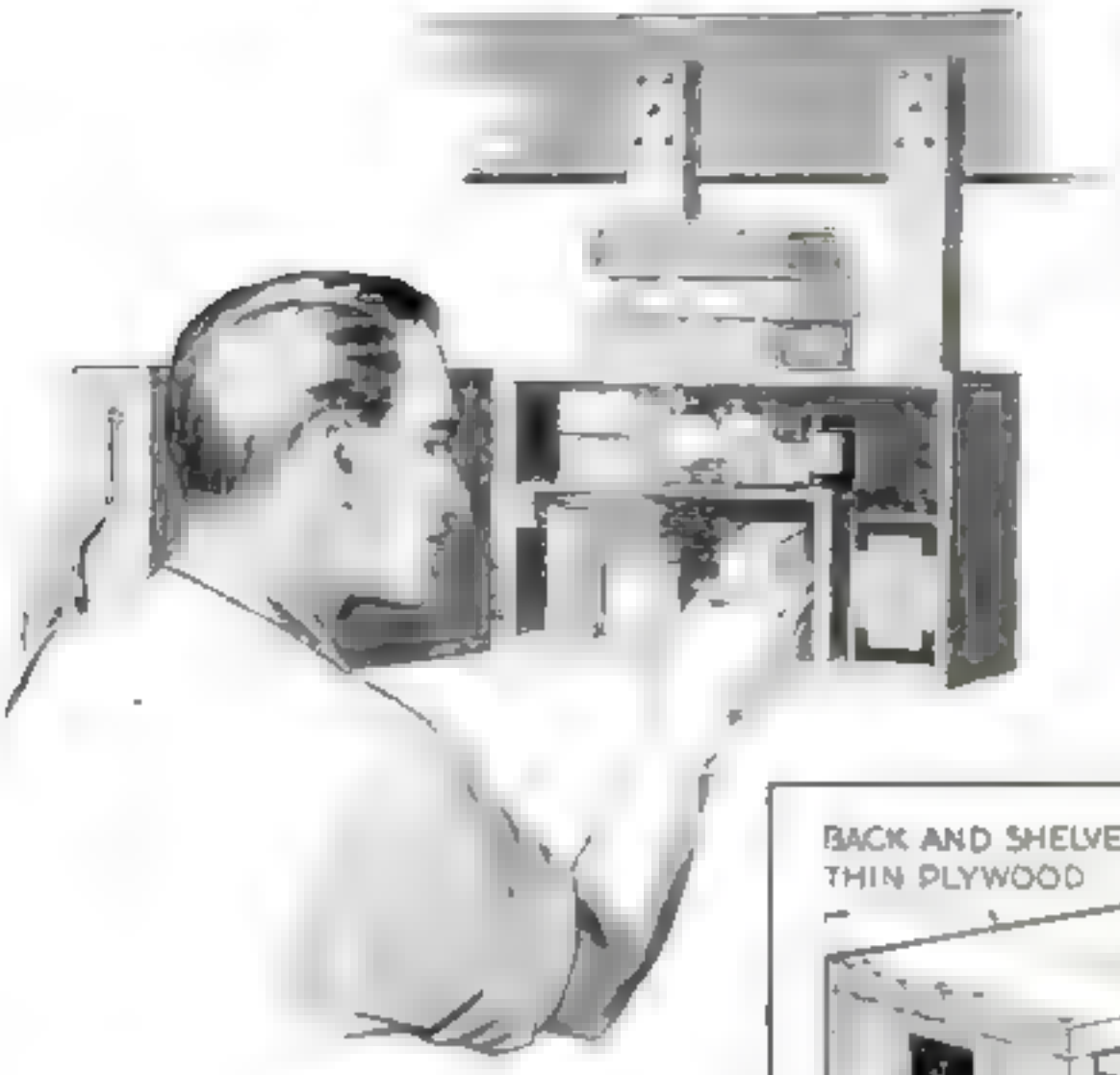
[SHOP METHODS]

Emery and flint papers are graded on a scale called, for the most part, before modern ultrafine abrasives were available, garnet silicon-carbide and aluminum-oxide papers are designated by a more recent and longer scale. A comparison of the grading systems follows:

Emery cloth No	Flint paper No	Garnet silicon-carbide, aluminum-oxide papers Grade		Mesh
		Out		12
		4½	Very coarse	14
		4	"	16
		3½	"	18
		3½	"	20
		3½	"	22
	3½	3	"	24
	3	2½	Coarse	30
3		2	"	36
	2½		"	
2½	2	1½	"	40
2	1½	1	Medium	50
1½		½	"	60
	1		"	
1		0	"	80
	½		"	
½		2/0	Fine	100
0		3/0	"	120
2/0	0	4/0	"	150
3/0	2/0	5/0	"	180
	3/0	6/0	Very fine	220
	4/0	7/0	"	240
	5/0	8/0	"	280
	6/0	9/0	"	320
	7/0		"	360
		10/0	"	400
			"	500
			"	600

POPULAR SCIENCE MONTHLY SHOP DATA FILE

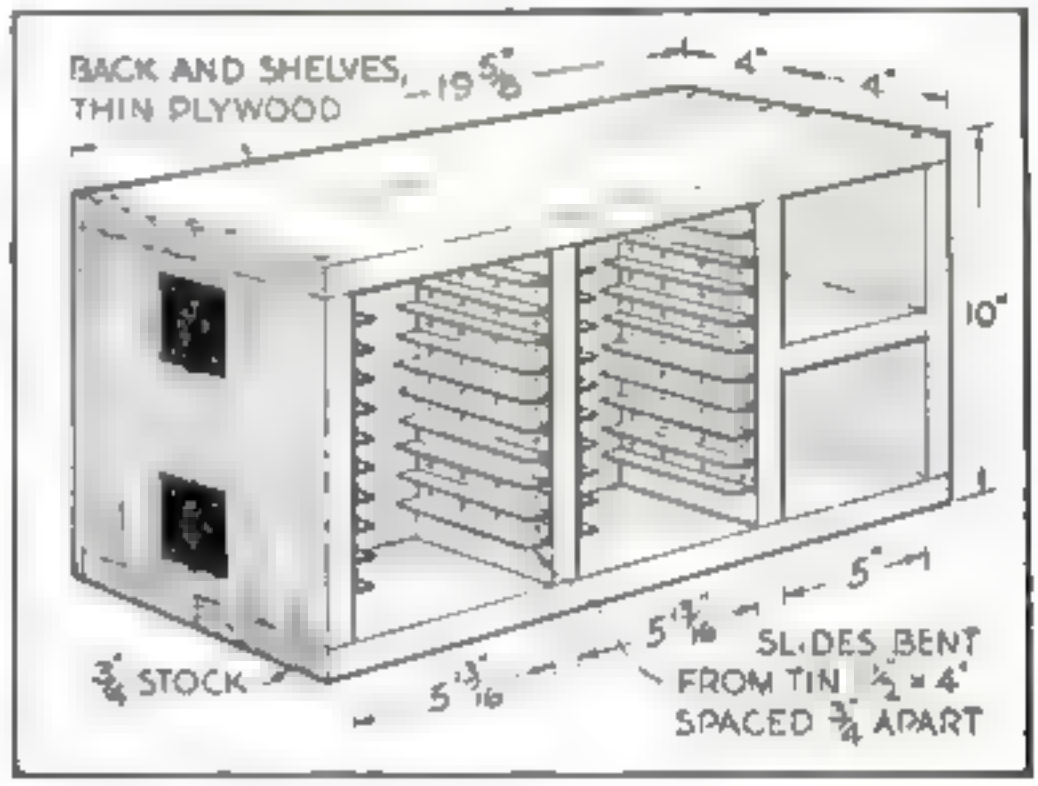
Double Cabinet Holds Shop or Photo Supplies



In the cellar darkroom or workshop, it is a simple matter to hang the cabinet from a ceiling joist in the manner shown above

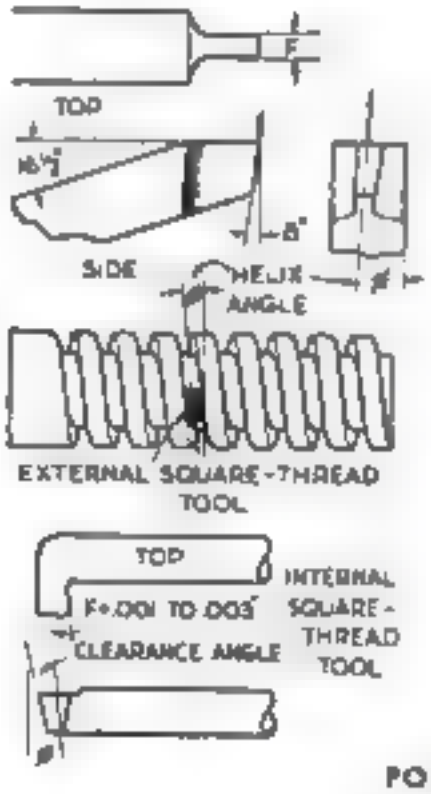
A neater job results if the back of the front section is set in or placed in rabbets. If wide stock is available, a single box frame can be made and then sawed apart

WHEN flat cigarette tins are used for storing screws and other small items, or photographic negatives, it pays to make a double cabinet for them as shown. The space in the back compartment is for spools of solder, glue, and other bulkier articles, or for developer, paper, and the like. Charts or data cards may be fastened to the back of the swinging section. Hang the box at eye level either from a joist or by attaching the rear compartment with screws to a wall.—WILLIAM J. FRITZ, JR.



SQUARE-THREAD TOOL BIT

[LATHE WORK—28]



The tool should be machine-ground if possible. Its heel is ground away to clear the thread at the bottom, the angle depending upon the pitch of the thread to be cut. The helix angle also must be very carefully calculated. Set the tool square with the work and exactly on center. It does all the cutting with the nose and must be fed into the work with the cross feed. Only very light cuts should be taken.

The square thread was once used much more widely than it is at present, especially on machine, adjusting, and power-conveying screws, but because it is hard to cut accurately, it is being replaced to an increasing extent by the Acme thread, which is stronger and easier to produce.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

Hand Planes

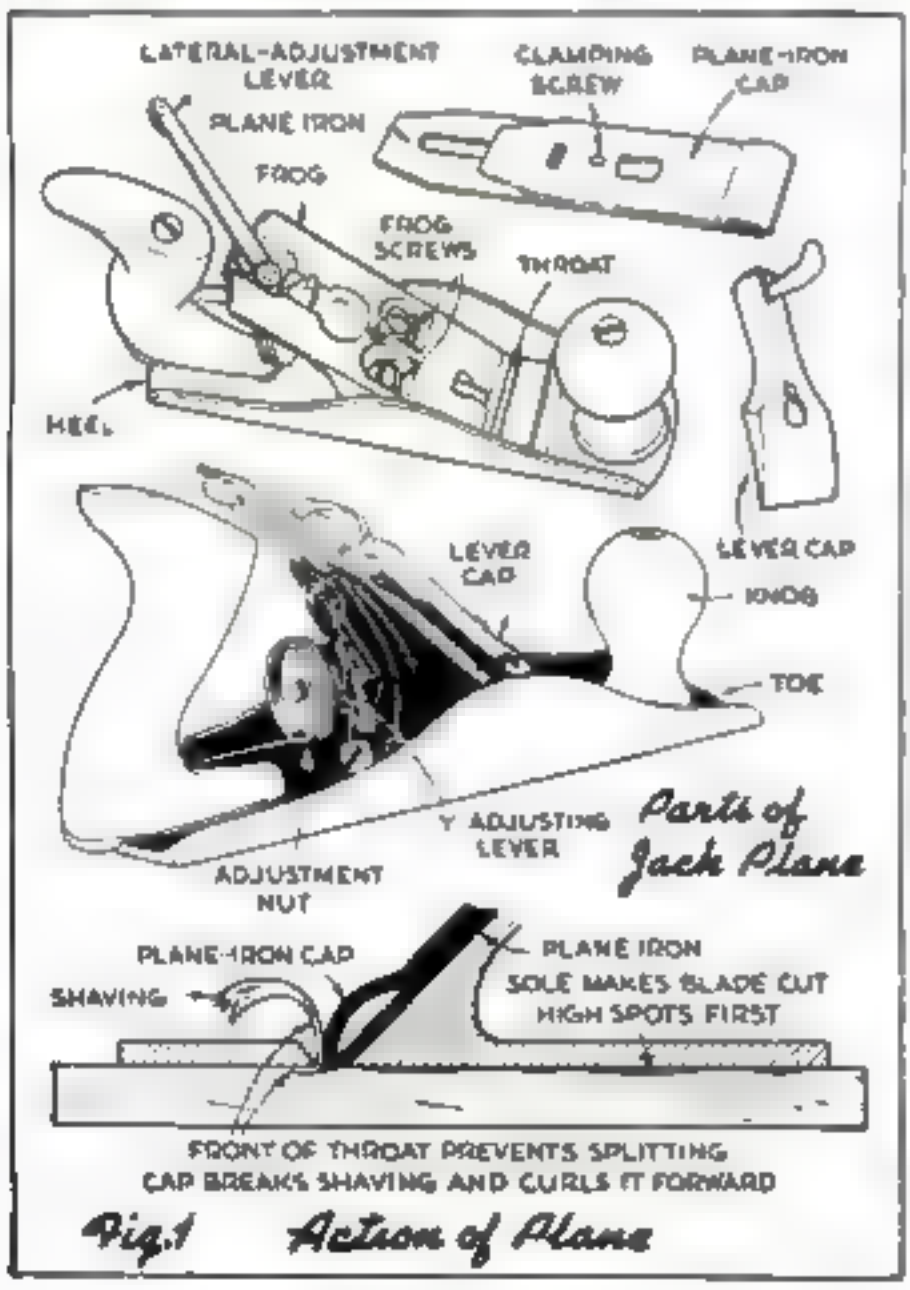
By EDWIN M. LOVE

EVEN though a home workshop may be well equipped with machines, there are occasional jobs that call for the skillful use of one or more hand planes. Dexterity in the use of these tools is therefore invaluable to any man who works in wood, and fortunately it can be gained by a little practice.

Which planes are most used in the home workshop? The jack plane, jointer, and the smoothing plane, which are all similar in construction. Jack planes are 11½" to 15" long, jointers may be 22", 24", or even 30" long, and smoothing planes are 5½" to 10" long.

What is the construction of a plane? Figure 1 illustrates the parts and their relationship to each other. Originally a plane consisted of a slotted block of wood into which an iron cutter, or a "single plane iron," was wedged, and the ancient term "plane iron" still survives, although today the blade is of steel. In a modern plane, this blade is attached to a cap by means of a large-headed screw, and the "double iron" thus formed is clamped to the frog with a heavy clamping piece called the lever cap.

How is a plane adjusted for use? Assemble the plane iron and cap so that the cutting edge projects beyond the end of the cap 1/64" to ⅛", this distance depending upon whether light finishing or heavy roughing cuts are to be taken (Fig. 2). Place the double iron on the frog (Fig. 1) with the small rectangular slot engaging the tip of the Y-adjustment lever. Then slip the lever cap over its screw to the end of its



Holding a block plane at a slight angle to its stroke helps to make it cut smoothly on end grain

and How to Use Them

keyhole-shaped slot, and press down the lever. The screw should be turned in far enough to make necessary firm hand pressure on the clamping lever.

Set the plane iron to the desired cutting depth by turning the brass Y-adjustment collar. You can now draw in either corner of the blade by shifting the lateral-adjustment lever. Sight along the sole of the plane, or rub the finger lightly along the bottom over the edge, to judge the setting.

For fine finishing cuts, especially on cross-grained material, loosen the screws holding in the frog and slide it forward to decrease the throat opening. In some planes the frog screws need not be loosened, adjustment being effected by turning a screw. Also, for fine cuts, set the edge of the cap close to that of the plane iron.

How can chattering and choking be eliminated? On seasoned wood, chattering or jumping is usually caused by a dull blade, or by looseness of the cap or frog. If shavings are forced up between the cap and plane iron, whet the edge of the cap on an oilstone until it fits closely against the iron. Besides this, it may be well to tighten the lever-cap screw. Chattering and choking will occur if the cap is set too fine, or if the blade is set to cut deep with the frog too far forward, that is, with a narrow throat opening

What is the proper way to resharpen a dull plane iron? The first step is to test the dull blade for squareness; if it is out of square, true it up on the edge of a rectangular sharpening stone. A slight crown is sometimes of advantage, as in the case of a jointer plane (Fig. 4). Now set a T-bevel to the angle at which the edge is to be ground—about 20 deg. for average work, or slightly more for very hard or knotty wood. Move the plane iron from side to side on the grinding wheel at the proper angle, using light pressure to avoid overheating. Check the angle frequently with the T-bevel. Grind until the dull edge resulting from squaring up the blade disappears. Then grind at still lighter pressure until a thin wire edge is formed on the flat back of the blade.

Apply a little oil to a fine, flat sharpening stone and move the plane iron back and forth lengthwise of it, bevel down, using both hands and applying pressure chiefly on the forward stroke. Start with the plane iron at a low angle and raise it gradually during the course of half a dozen strokes until the bevel lies flat on the stone. Shift the blade from side to side with each stroke so that all parts of the edge will be sharpened. Round the corners slightly.

Finally, turn the blade iron over, bevel up, and with it perfectly flat on the stone, take a few strokes to turn the wire edge back. Remove this burr either by stoning both bevel and flat again lightly, or by drawing the edge against a piece of hardwood. Test for sharpness by resting the edge of the plane iron on the thumbnail. If it "bites" of its own weight it is satisfactory; if not, it should be resharpened. Avoid nicking the edge when replacing the iron in the plane.

What are the steps in smoothing a board? Choose the best side and level down the high spots with a jack plane. Then take overlapping strokes lengthwise of the board,

The spokeshave is useful for planing irregular curves, and may be pushed or pulled as preferred

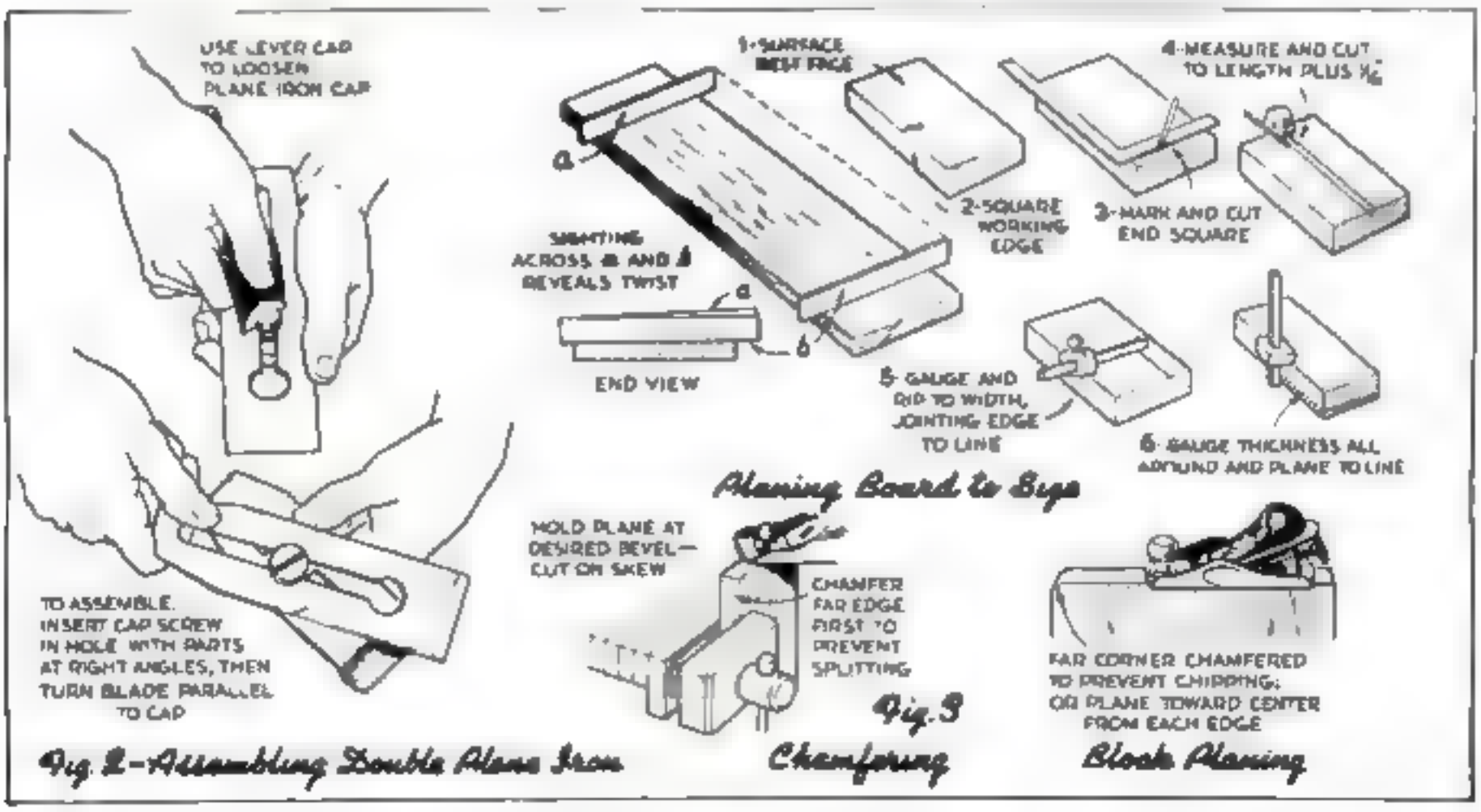
In jointing a board, lift the plane at the end of each stroke to avoid rounding the far corner

A cabinet scraper is used lengthwise of the work and turned at an angle to afford a shearing cut

Plowing a groove with a combination plane. It will also cut rabbets, dadoes, tongues, beads, and coves

working from left edge to right, and after this use a smoothing plane. If the board is thin, or wide and long, you may have to disregard wind and cupping. However, Fig. 3 illustrates how it is possible to test for wind, as well as successive steps in planing a board to size.

How are the edges of boards straightened? Push the jointer along the edge, the full length of the work where possible. Bear down on the toe of the plane at the start, and on the heel at the end of the stroke. As a further precaution against rolling the toe downward, lift the jointer when the plane iron clears the end, as shown in one of the accompanying photographs. Carry it back to start the next stroke. Dragging the plane back dulls the edge needlessly. It is often best to place the finger of the left hand under the sole to act as a fence, (Fig. 4),



keeping one section of the plane iron cutting the full length of the stroke. Thus, if one corner is high, the crowned section of the plane iron can be moved to that side to take a deeper shaving there.

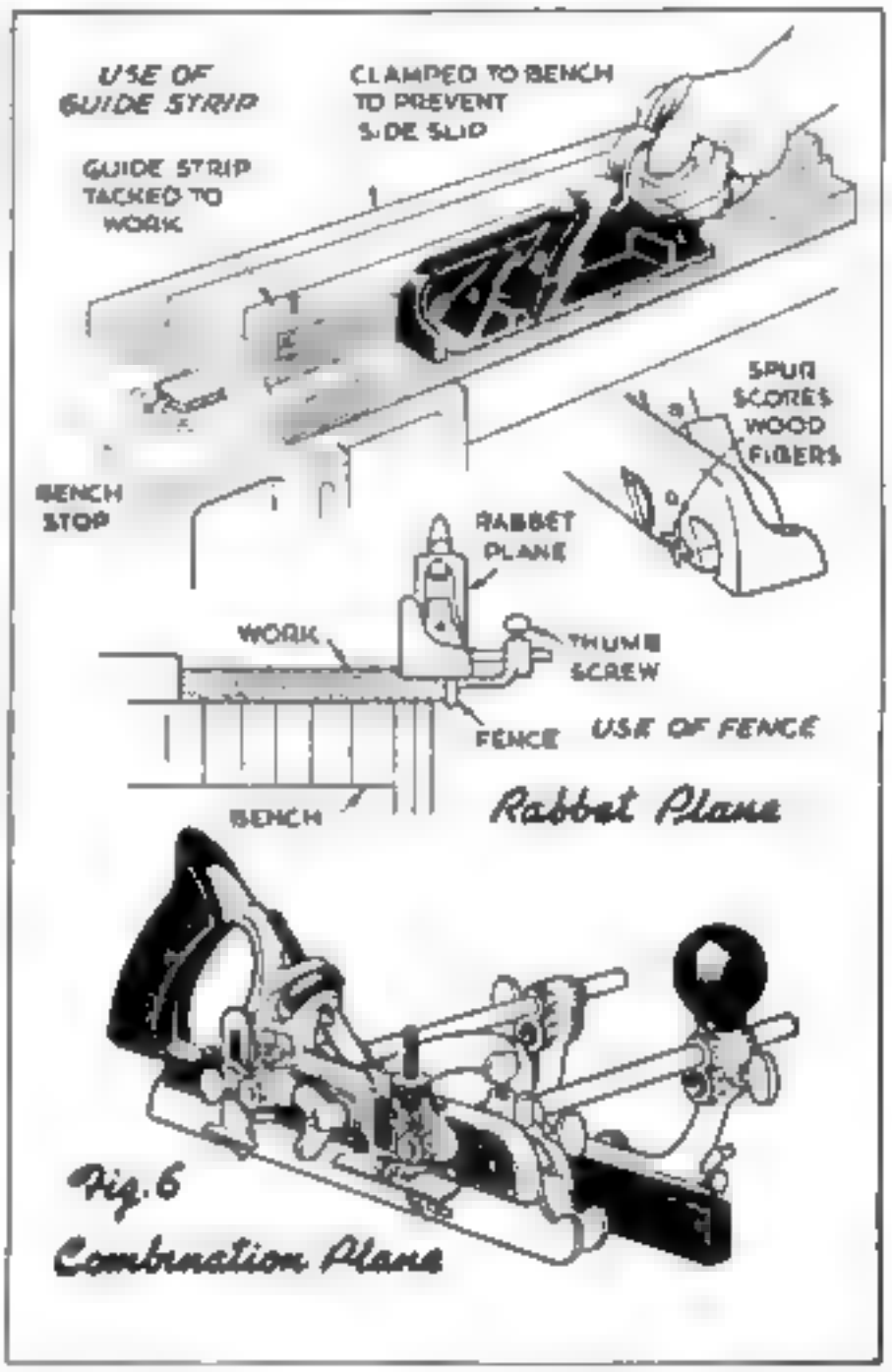
Boards jointed for gluing need not be square, but the bevels must be such that the faces will be parallel, as shown in Fig. 4.

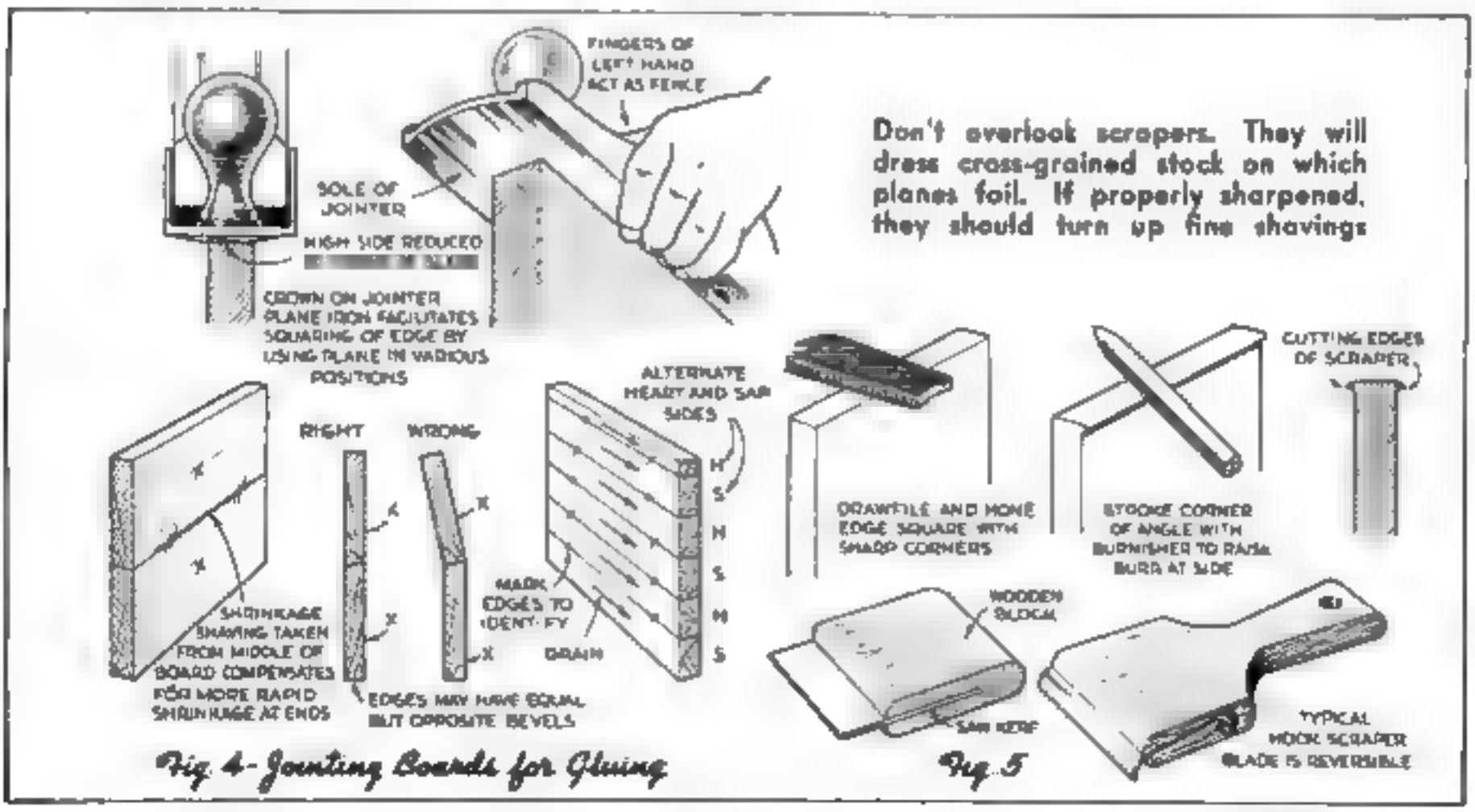
Of what value is a scraper? The scraper, by virtue of its fine, burred edge, which crimps over the shaving as it leaves the work, will smooth cross-grained boards that are hard to dress with planes (Fig. 5). However, because it crushes softwood, its use is generally restricted to hardwoods, although fir lumber is often scraped.

How is a spokeshave used? It is either pushed or pulled, according to working convenience and the direction of the grain. A simple method of setting the blade is to rest the sole on a block of wood and slip the blade down until it touches. With the screw partly tightened, tap the top end of the blade lightly with a hammer to set the edge out, and clamp it tightly.

Is a rabbet plane a useful tool in the home workshop? It is really a necessity for making stepped cuts, such as recesses for cabinet backs. See that the blade is sharp and square, and in line with the side of the body and the spur, and use the fence or else a tacked-on guide strip as shown in Fig. 6. Take a substantial full-length shaving. Resist the tendency to slide out of the rabbet. If this happens, trim the cut with a chisel and use the plane again. In cutting end rabbets, it is better to saw the shoulders than to depend on the spur to sever the fibers of the wood.

Are combination planes used in the home workshop? Although few home shops have one, this tool is invaluable for hand work, substituting for the rabbet plane and cutting dadoes, grooves, tongues, beads and coves. More elaborate models are also equipped for making moldings.

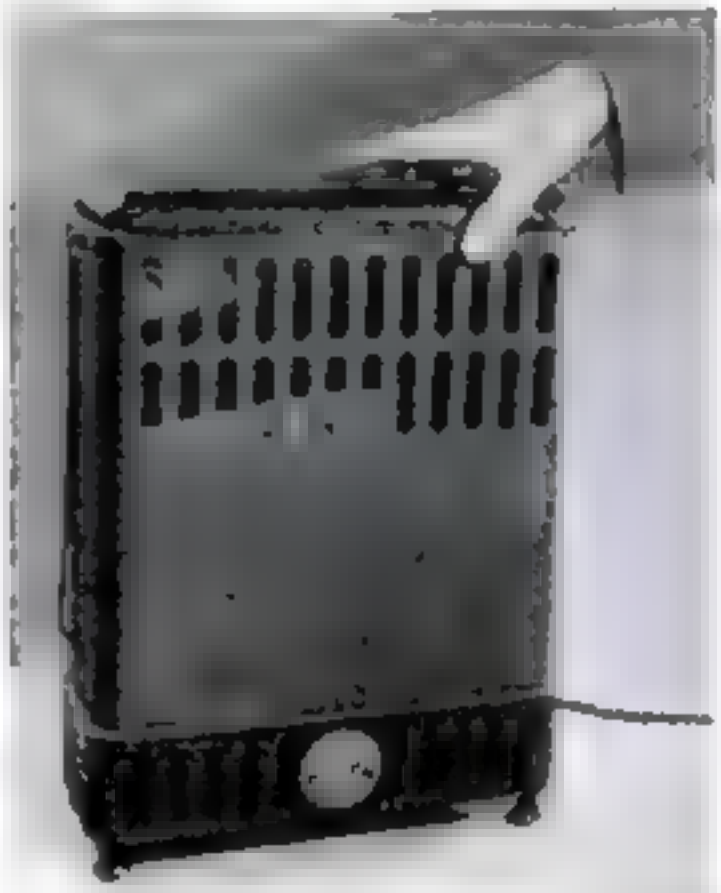


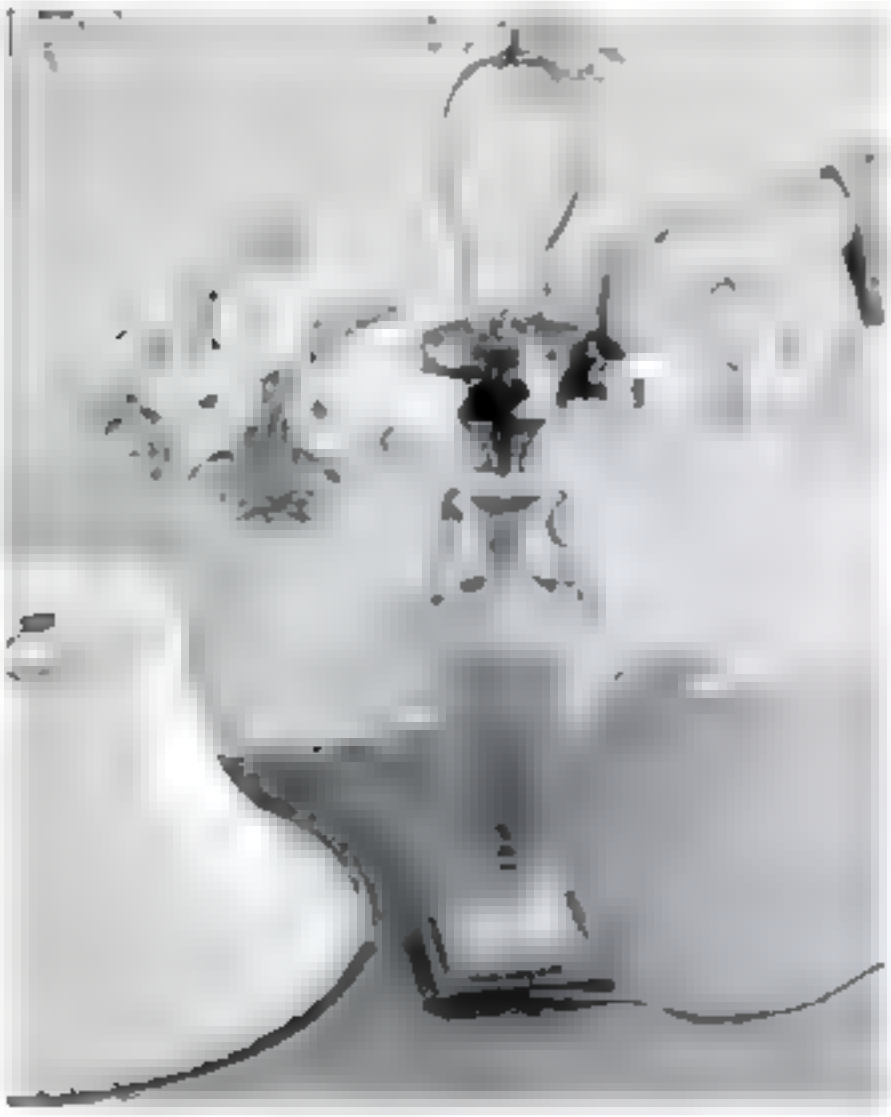


New Appliances

PLASTIC AND UPHOLSTERY are combined in the construction of a new chair of modern design. Transparent plastic is used for the curved arms and supports, taking the place of metal and wood, and the upholstered seat and back require only two yards of material. Arms and cover are in contrasting colors

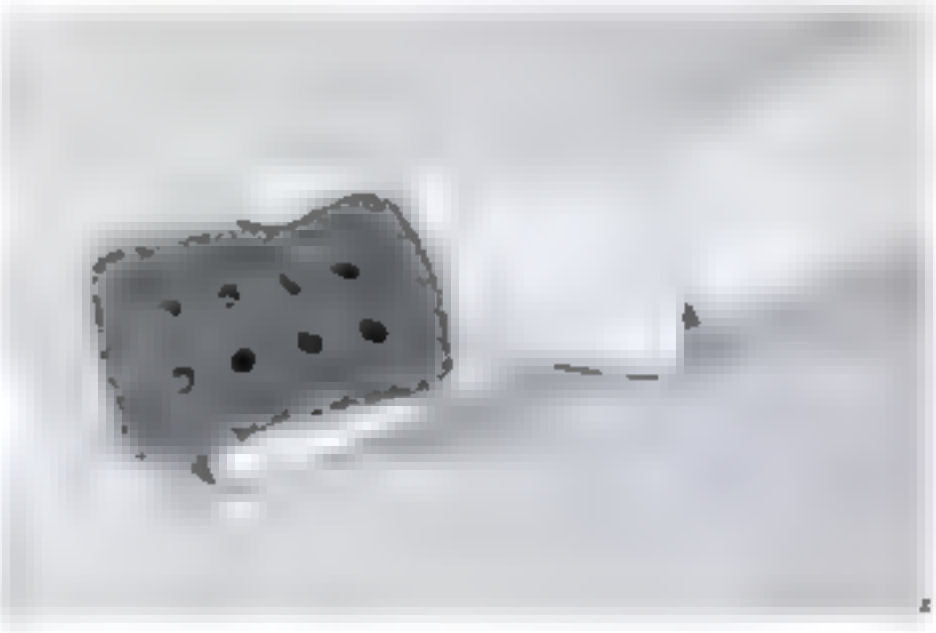
"BLACK HEAT," a recent discovery employing a large woven element of filament and spun glass to generate warmth with no visible glow, is used in the new portable electric heater below. The unit is light enough to be carried in one hand. If knocked over, it will shut off automatically



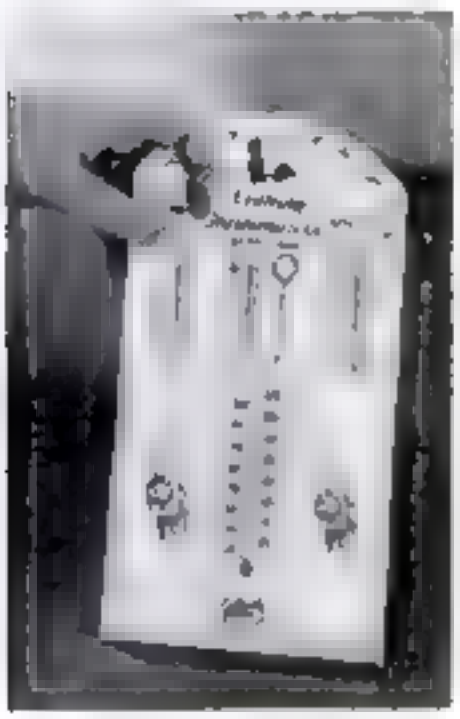


A FLUORESCENT TUBE of circular shape, 8" in diameter, is now made for table lamps. It can be bought either complete with a lamp or separately for installing on an old one that has been rewired

GLOVE AND SPONGE ARE ATTACHED in this new house-cleaning device. It is especially useful for washing windows and tile. The rubberized gauntlet protects the hand, and no fatiguing grip is needed



for the Household



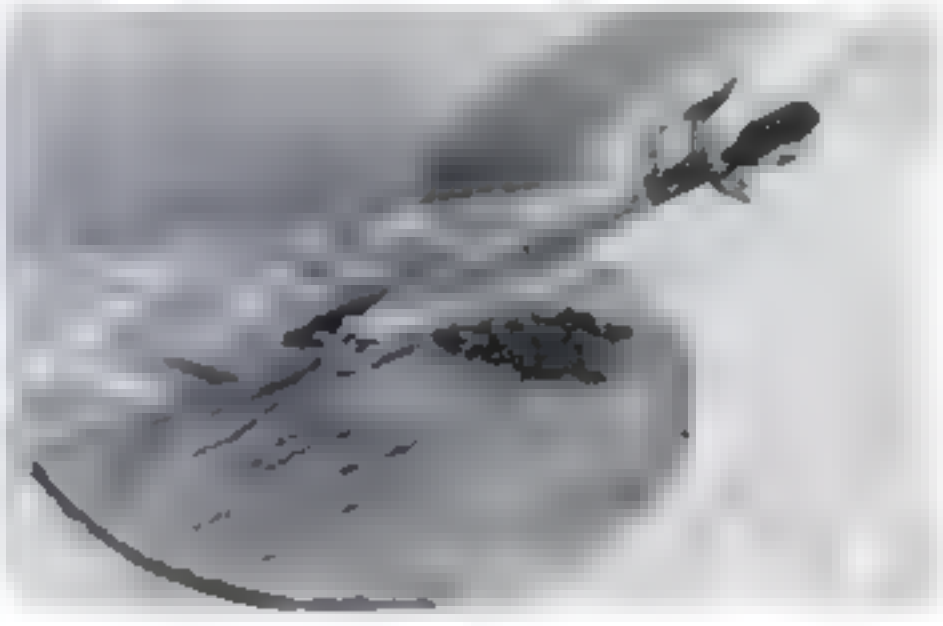
THERMOMETER SETS for the kitchen may be had in a wall rack of enameled pressed wood. In pockets are three cooking thermometers—for candy, roasts, and deep-fat frying—and a skewer, and on the holder is a room thermometer. The oval tubes make temperature reading easy and keep the instruments from rolling off the table. All glass is heatproof

TAILORS' POWDER in a small plastic case fitted with a tracer wheel will be found an aid in transferring patterns to cloth and in marking for alterations. The case opens for refilling. The powder comes in red and white

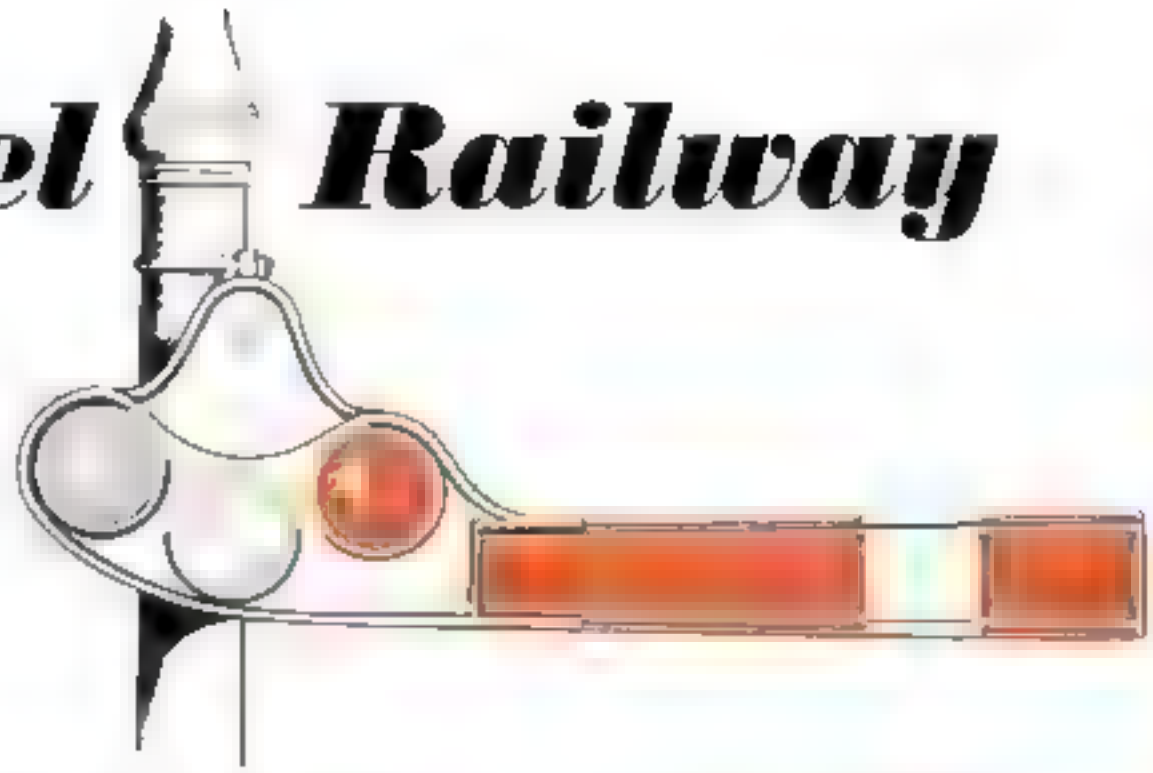
BROILING, GRILLING, AND TOASTING are done in an ordinary frying pan covered with the electric lid shown above. The appliance uses a standard cord and plugs into the average household outlet. It can be cleaned easily after unscrewing the knob on top and taking out the electric element. The lid may be washed, but the heat unit should only be wiped dry

TARNISH ON SILVERWARE is prevented by a new chemical compound placed with water in a special container where its vapors will counteract the effect of the atmosphere. Evaporation continues from three to twelve weeks without replenishing

KNIFE AND CHOPPING BOARD are a unit in this vegetable-slicing set which permits the swinging motion employed by professional chefs. The knife is fastened at one end to a rotating pivot on the board. It is removable for cleaning and sharpening



Model Railway



By
DAVID MARSHALL
Author of Model Railroad Engineering

RAILWAY signaling is one of the most fascinating of the applied sciences, and one that has been carried to the peak of efficiency. Its application to a model pike brings new operating thrills, for it can be made to follow standard practice closely. Indeed, model layouts have served as laboratories for working out signal problems on the big roads.

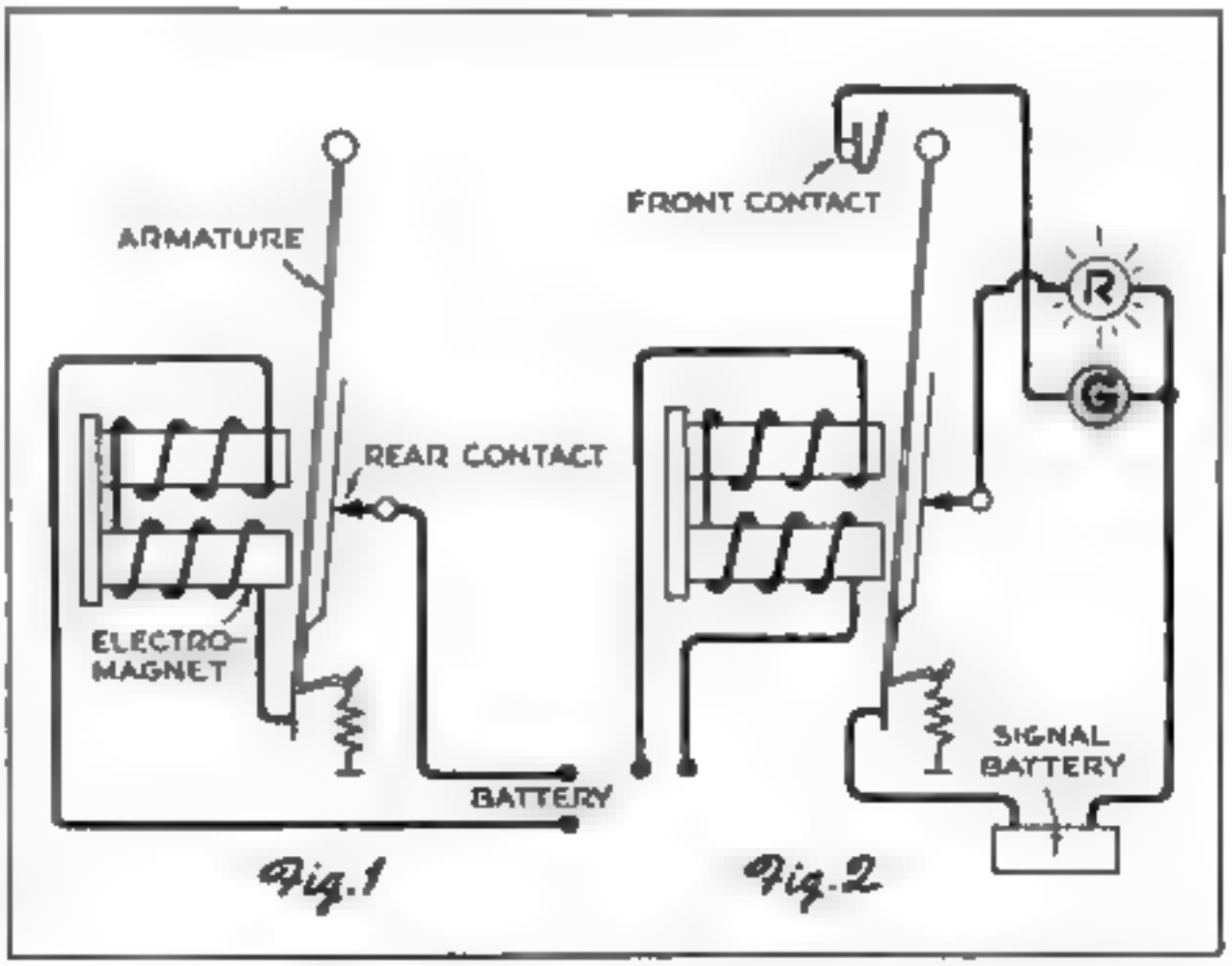
The first principle of good signal engineering is that every part must operate perfectly to produce and maintain a *clear* indication, such as a semaphore in the upright position. A *stop* indication must result automatically if any part fails to function. Should a wire break or current stop flowing, the semaphore blade must fall to the *stop* position by gravity alone, or, in the case of a light signal, the heavy armature of a relay must drop of itself to close the circuit of the red light. Thus mechanical or electrical failure can have no effect but to freeze a signal at *stop*, halting the operation of trains.

TRACK RELAY. The heart of automatic signaling is the track relay, an electromagnetic device for making and breaking electric circuits. The track relay is operated by a *track circuit*, and in turn controls a *signal circuit*, either supplying the power required to sustain a *clear*, or breaking the signal circuit to let the signal drop to *stop*.

You can buy a relay for a dollar, or you can make one out of a 20-cent doorbell. In Fig. 1 the parts of such a bell are shown diagrammatically as wired to produce a ring or buzz. In Fig. 2 the same doorbell, altered to serve as a track relay, is connected to a light signal. A front contact consisting of a piece of spring brass is attached, and the magnet winding is no longer in series with the armature, but connected to a separate track circuit.

When the magnet is energized, the armature is drawn toward the front contact and held away from the rear contact. In the diagram, the magnet is not energized, and current flows through the red *stop* light. When the magnet is energized, the red light blinks out and the green flashes on. If the track circuit is again broken, the spring pulls back the armature to close the *stop* circuit again.

TRACK CIRCUIT. In signal engineering, a given track is subdivided into "blocks" or space intervals; and the entrance to each is protected by a signal. Where two blocks meet, the abutting railheads are insulated, so that within the block both rails may act as con-



Signaling

ductors, yet no current can flow from one block to another.

In standard practice (*A* in Fig. 3) each block has its own track battery and track relay. From the battery at the far end of the block, the current normally flows through the entire length of one rail, through the track relay, and thence through the other rail back to the battery. Thus the relay is normally energized, and the lifted armature closes the *clear* signal circuit, as in the upper block at *A*. Once a train enters a block, however, its wheels short-circuit the rails; the battery current returns without energizing the relay, which reverts to normal, the armature drops (by gravity in the case of grown-up railroads, for springs are not permitted) and the *stop* signal circuit is closed. Notice that, whatever the condition of the block, the current from the track battery is forever flowing.

Some railroads argue that they cannot afford the high cost of this closed-circuit system, so the older open-circuit system is still used here and there. In this (*B*, Fig. 3), the track current flows only when the block is occupied. The relay has to be energized to produce a *stop*, and if a connection works loose or the relay refuses to "pick up," a false *clear* is given. In actual practice, fortunately, a false *clear* is rare. Model railroaders use both systems, simplified with one track battery for the entire railroad (*C*, Fig. 3). Only one rail is broken up into blocks. This is called the control rail; the other is the common rail.

SIGNAL CIRCUITS. These also are simplified in model railroading, and all the signals are operated from a single battery (Fig. 4). It will be noticed that the signal circuit also makes use of the common rail, yet the signal and track circuits never mix. (TO BE CONTINUED)

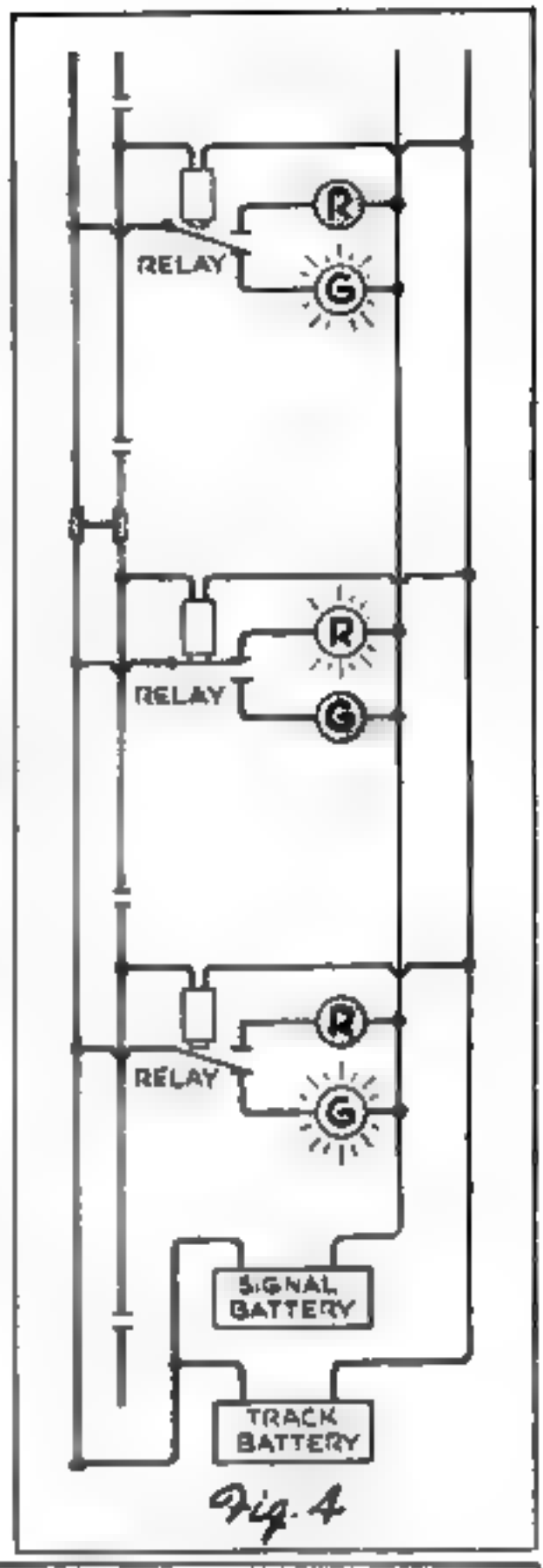


Fig. 4

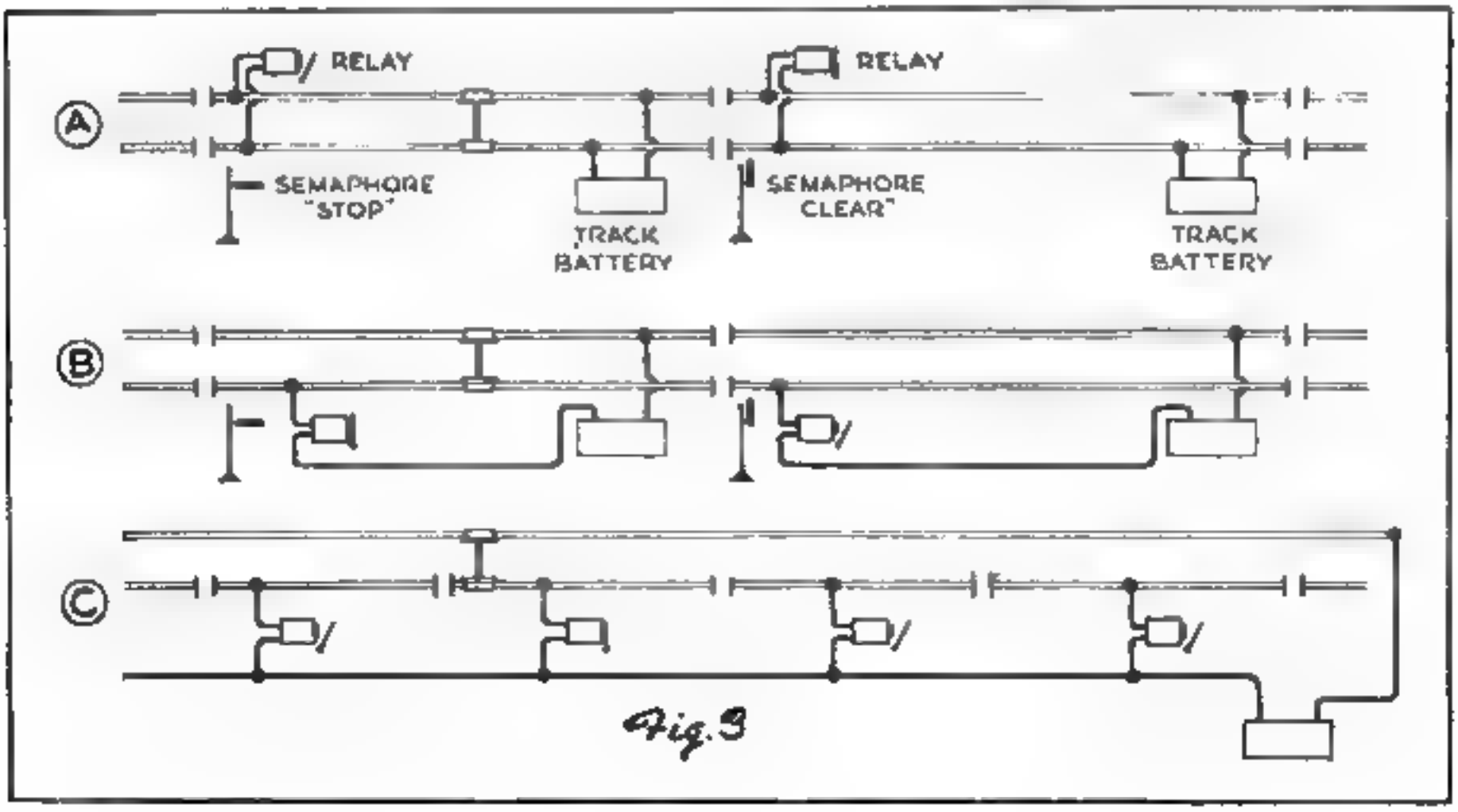


Fig. 3

Plans, templates, and an unpainted model of the type to be used for training fliers and plane spotters. Models must be finished dull black

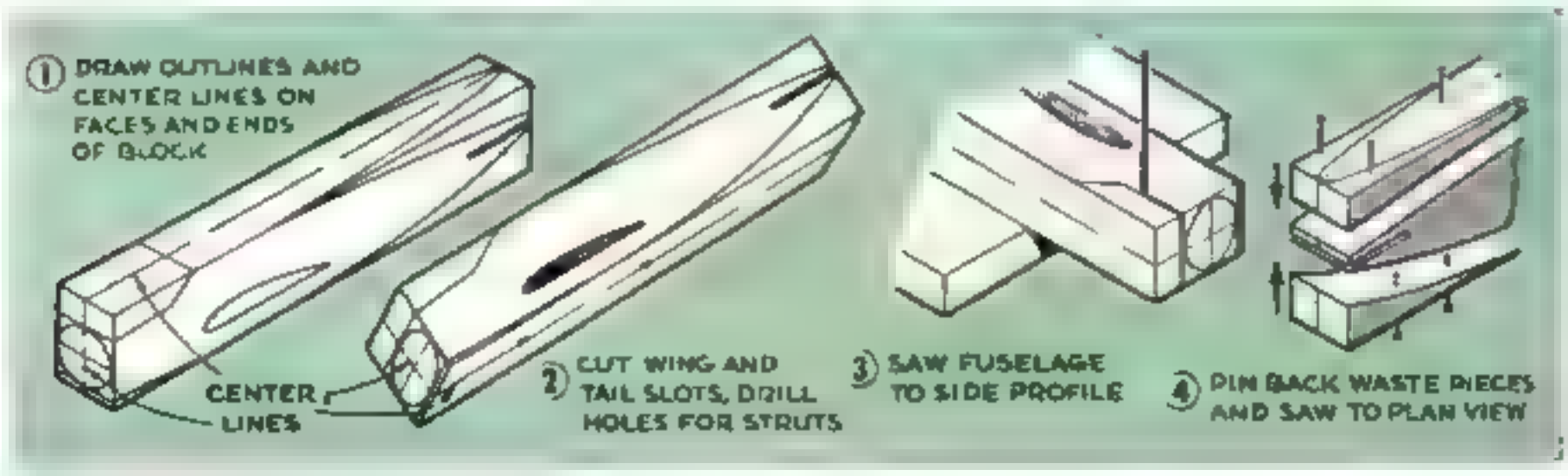
How to Make Scale-Model

By FRANK ZAIC

WITH 500,000 miniature planes required immediately for the training of Army, Navy, and civilian personnel (see P.S.M., April '42, p. 79), and the likelihood that still more will be required, every patriotic builder of models is likely to ask, "What's needed and how can I do the job best?"

Full-size plans are to be distributed by local school superintendents, and there are to be fifty different designs or plans in all, of which a typical one is shown above. All models are to be built to a uniform scale of 1" to 72", so that 35' away they will look exactly like their prototypes at a distance of a little less than half a mile. The tiny craft will be subject to much handling and must be made of substantial materials such as poplar, white pine, basswood, or whitewood. Models made of balsa will not be accepted. Avoid using knotty or resinous wood. The glue used should preferably be of the new resin type, and not ordinary model-airplane cement, which tends to peel off when used on close-grained material.

It is not necessary to have windows, propellers, and other small details on these models. Their purpose is to train air fighters and spotters to identify our own and Axis ships at a distance of half a mile by wing, tail, and fuselage outlines. Details are not



visible on a full-size plane at that distance and are therefore superfluous on the models.

The first step in making any number of these models is to glue the full-size patterns to a backing of sheet fiber or tin-can metal before cutting them exactly to line. Both pattern and backing are then trimmed together. Such reinforced templates may be used again and again.

The accompanying drawings illustrate the step-by-step procedure in building a model of the Vought-Sikorsky OS2U-1 U. S. Navy Observation Scout. This involves the making of a pontoon and two floats in addition to the fuselage, wing, and tail. With a very sharp pencil, lay out both side and plan-view fuselage profiles on a squared-up block of suitable size, together with center lines on the top, bottom, and ends, as in Fig. 1. While the blank is still square, saw out the wing and tail slots, and drill the holes for the struts (Fig. 2). Saw the blank to the side profile as in Fig. 3. Pin back the waste temporarily to make the work easier to handle, and saw out to the top or plan view as shown in Fig. 4.

Plans include cross-section templates, but instead of using these merely to check the fuselage after shaping, inscribe the curve of each within a drawn rectangle exactly the size of the hull cross section at that particular station (Fig. 5). Against this curve draw tangent lines as shown. With dividers or a scale, take off the intervals *A*, *B*, *C*, and *D*, and on the fuselage blank scribe lines spaced at such intervals from the edges and center lines.

It is now easy to carve the fuselage roughly to shape (Fig. 6). Work down only to the lines, keeping the carved surfaces perfectly flat. If you attempt to rough out and round off at the same time, you will lose the guide lines.

WHAT YOU CAN DO FOR DEFENSE

When the fuselage has been roughed out all over, you are ready to carve it to the final shape. Use the templates freely as you work, and finally sand this part smooth (Fig. 7).

To make the models capable of withstanding hard usage, the wing, tail, and rudder must be securely attached. Cut the fuselage from the bottom up to the wing slot, and from the top down to the tail slot as shown in Fig. 8. Save the pieces. Cut the one from the tail in half lengthwise.

Tail surfaces have thin, streamlined airfoil sections. Merely rounding off the corners will leave the model looking like those that are used to decorate barns. An easy way to shape tail and wing airfoils properly is shown in Fig. 9. Tiny thumb planes will be found useful in beveling the surfaces roughly to shape. Round off the corners and sand all smooth afterward. Use care in cutting tail surfaces to shape, as planes can often be identified by these alone.

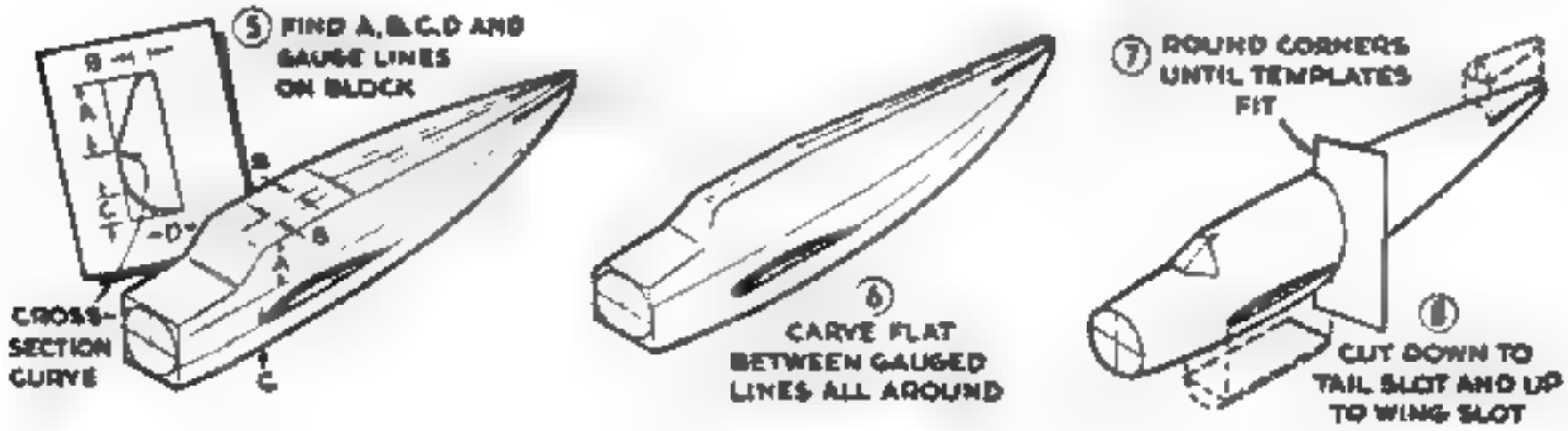
The stabilizer is glued to the flat of the tail slot. The plan shows the rudder as it appears above the fuselage, but actually the rudder is cut longer so that it may be glued to the top of the stabilizer. The two halves

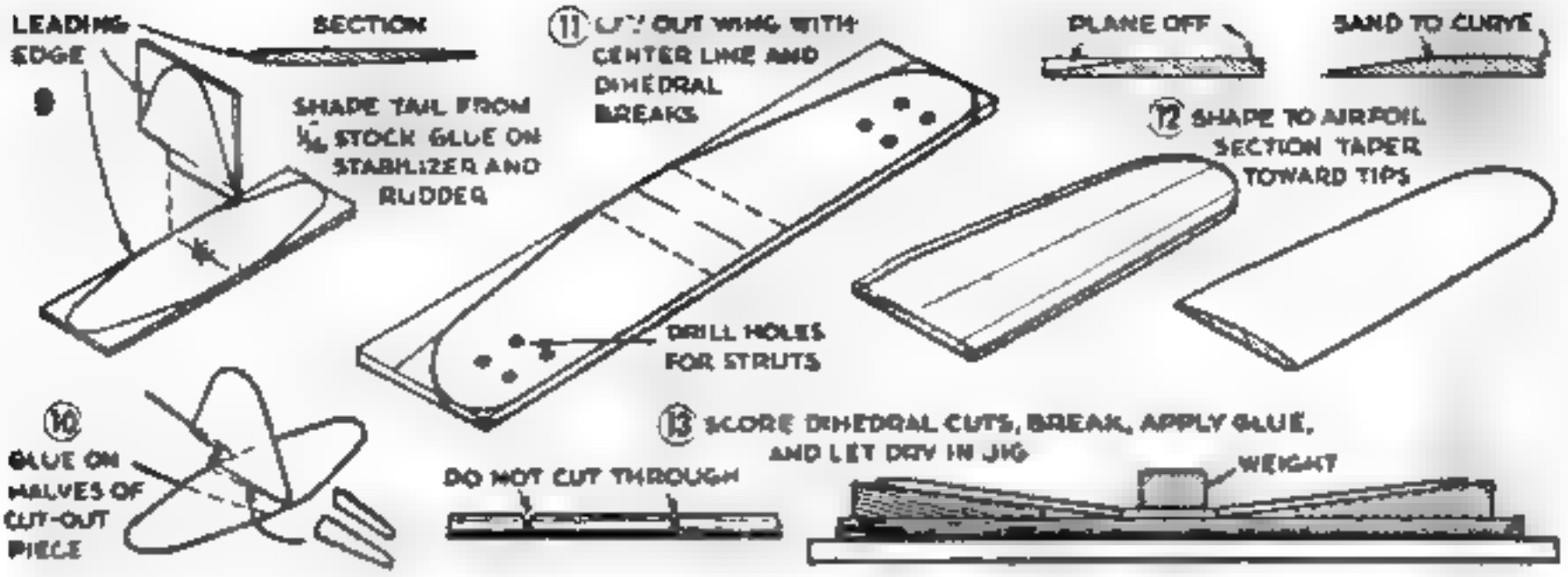
Planes for Government Use

of the section previously cut out are sanded to a good fit and glued in on either side to bring the fuselage to shape and reinforce the rudder (Fig. 10).

Lay out the wing, including the center line and the two lines indicating the dihedral break (Fig. 11). Cut to outline and shape to a true airfoil section as in Fig. 12. Taper the wing toward the tips as called for in the plans. In some wings the top is tapered toward the lower surface, but more often the lower one tapers upward. Finish smooth with fine sandpaper.

The wings of modern fighting ships have a considerable dihedral angle. This is best formed by making V-shaped cuts along the





lines marked and raising the wing tips until the wood just cracks but does not break off. Apply glue freely to the V-cuts and place the wing in a jig (Fig. 13) to set. Check the dihedral, as given by the gauge, against that shown in the projection drawings, as the template may not prove accurate for so small a model.

Pontoons and floats are made in the same way as the fuselage (Figs. 14, 15, and 16).

Small struts should be made of a hardwood such as maple. Shape them to the correct cross section shown in Fig. 17. Never leave them square or rectangular, or be content with simply rounding the corners.

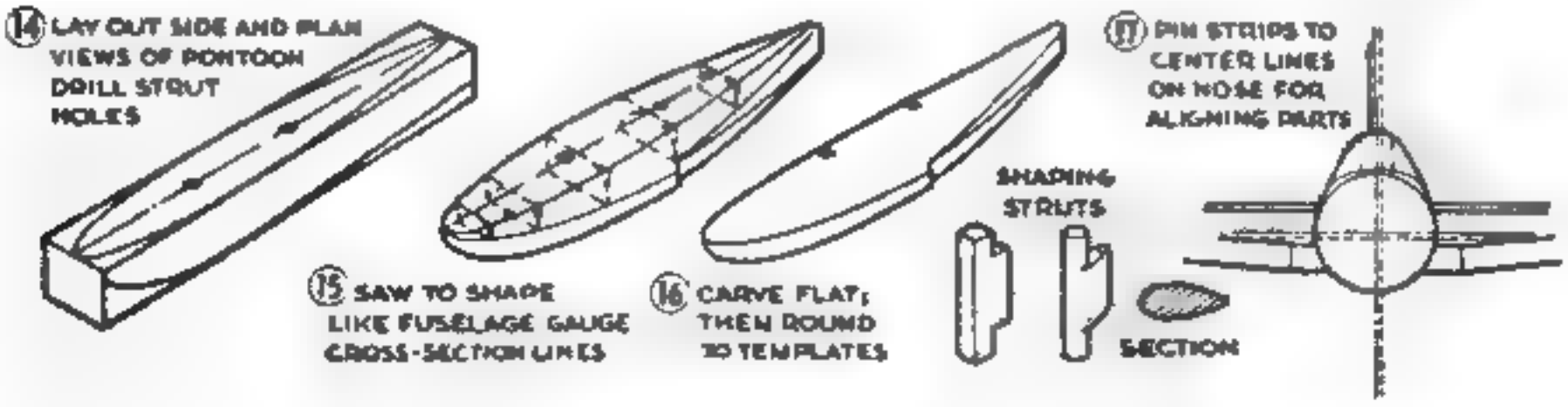
The center lines drawn on the nose are used in aligning the wing and mounting the pontoon. Pin thin strips along them as shown in Fig. 17. Use these to sight across as the plane is being assembled.

Glue the wing into the slot provided for it, and glue in the cut-out piece below it. This is a stronger and easier method of mounting the wing than that of using dowels or a butt joint. Do not worry about cracks left around the wing section in the fuselage. These can easily be filled with glue.

The resin glue to be used is somewhat similar to casein glue, except that it is mixed with less water and is ready for use immediately. It sets in a few hours. If work is held near a radiator or left in a warm place, half an hour will suffice for surface drying. Once the glue has set, the adjoining wood will rupture before the joint itself. Within 48 hours the glue hardens to a rock-like consistency, so be sure to work cleanly and leave none where it does not belong. If glue fillets or the like are to be finished, sand them smooth within four hours.

The models must be finished dead black, with no gloss, like the inside of a camera. Poster color or flat black oil paint will do. However, several thin coats of ordinary wood filler should first be applied to close the pores. Sand the plane perfectly smooth afterward. When the surface shows no grain, the black paint may be applied. Two coats should suffice. Paint them on smoothly.

If many of one type of model are to be made, jigs should be used whenever possible —for obtaining the dihedral angle, in assembly, and for marking fuselage blocks. The work should be divided so that those having power machinery can cut or rough out parts, leaving finishing to those who can use only hand tools. A penknife, a small drill, one or more thumb planes, and sandpaper comprise almost all the tools needed for the final shaping, fitting, and assembly. The U. S. Navy, which sponsors this model-building project has already sent plans for the Vought-Sikorsky and nineteen other planes to participating high schools.



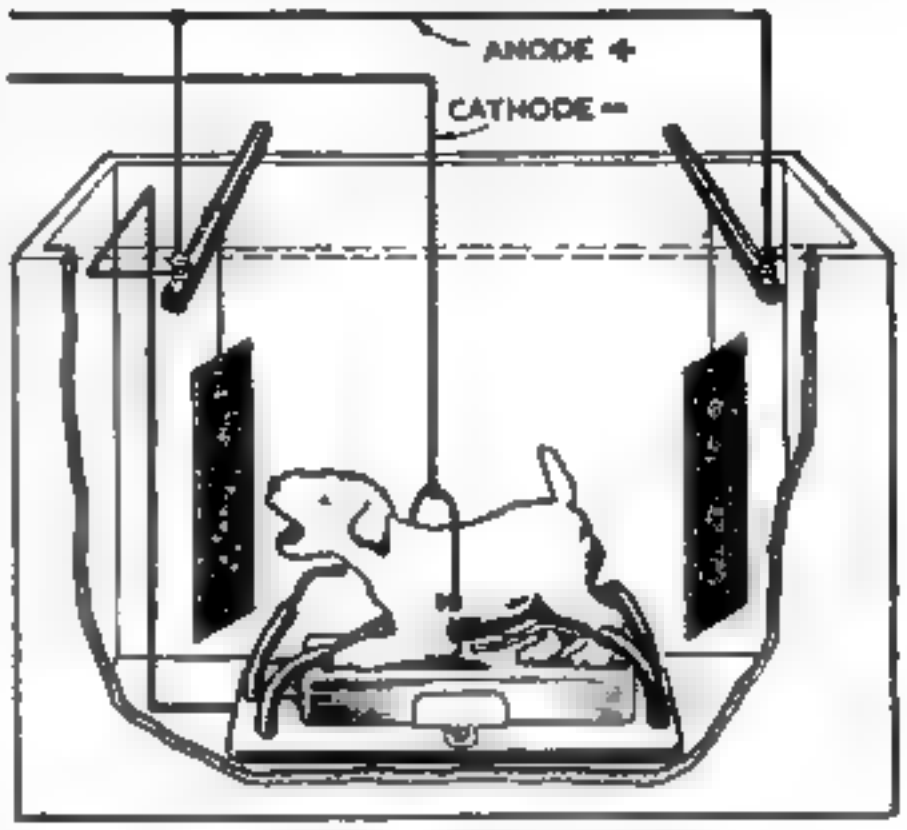
Simple Fixture Insures Even Plating of Irregular Work

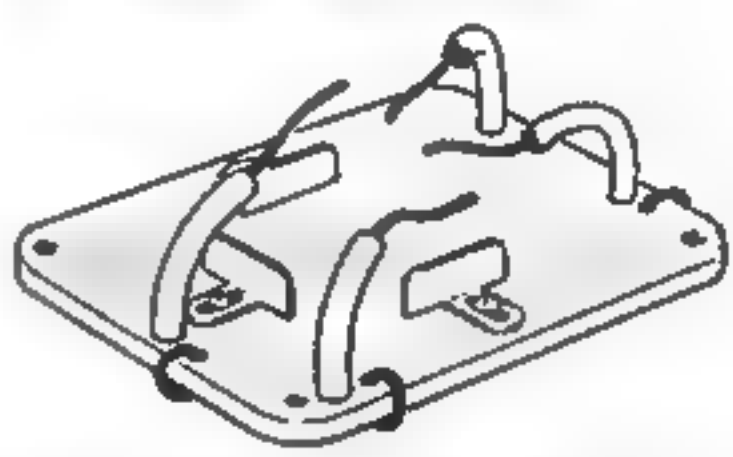
THE AMATEUR often finds it hard to obtain a satisfactory deposit on undercut and sunken areas of an article being electroplated. This is because the plating current follows the path of least resistance, building the heaviest deposit nearest the anode

A simple fixture that insures even plating is shown in the illustrations. The base, of pressed composition wood, hard rubber, or plywood, is cut slightly larger than the article to be plated. With small brass screws, attach three copper or brass clips to hold the work centered. Set it in place, and mark the board about ⅛" from the edges opposite all hollows.

After removing the work, drill holes at the points marked to a tight fit for No. 12 enameled copper wire. Drill a second hole, also ⅛" from the edge, about ⅛" from each of the others. If a wooden base is used, it should then be boiled in paraffin. Push each wire up through one hole of a pair so that a generous length protrudes. Carry the other end over the edge of the board and down through the second hole. Connect all the wires together under the baseboard, and carry off a lead for connection to the current source. Solder all joints. Remove insulation a short way back on all wires. Bend them to fit in sunken areas without touching them.

For plating copper, no further preparation is needed. To plate other metals, place the fixture in the plating bath without the work and deposit a heavy plating upon the wires, which for this purpose are connected to the negative side of the line. Set the work in





place, surround it with anode plates as necessary, and connect the fixture wires to the positive side of the line with the anodes. Plate for half the usual time, then remove the fixture and finish plating in the ordinary way.—K. R. SIPPLE.

ELECTROPLATING, PART 11 [ELECTRICAL]

Copper plating is an important process not only for finishing articles, but also as a treatment preliminary to the plating of other metals. Copper deposits very readily in an acid solution, but work consisting of iron, steel, or zinc must receive a preliminary plating in an alkaline solution After being thoroughly rinsed, it may be transferred to the acid electrolyte until the plate is of the desired thickness. If it is placed directly in the acid solution, a thin unstable deposit is formed, and the plating will not be durable

Acid electrolyte. Dissolve 1¼ lb. copper sulphate in a quantity of hot water, then add cold water to make 1 gal. When this is cold, slowly add 3½ oz. sulphuric acid, meanwhile stirring with a glass rod Use 1½ to 3 volts for plating

Alkaline electrolyte This is extremely poisonous. Use the utmost care in preparing and employing it. Do not allow it to come in contact with the skin. *Never add acid to the alkaline solution, for deadly fumes will be generated.* In 2 qts. warm water dissolve 1 lb. sodium cyanide (POISON). Add 8 oz. copper carbonate slowly, stirring until the solution is clear. Then add 2 oz. sodium carbonate and water to make 1 gal. Use 3 to 4 volts for plating. Unclean alkaline solution may cause blisters on the work. Rinse plated articles in hot and cold water alternately several times before transferring them to the acid bath. The acid solution should be agitated frequently to prevent depletion of the metal in solution between the anode and the work Too much voltage may result in a dark or burned deposit or blisters. Regulate the current so that the color of the work remains a rose tint. A good grade of sheet copper will serve as an anode

POPULAR SCIENCE MONTHLY SHOP DATA FILE

IMPROVE YOUR HOME NOW

Here's a practical closet that provides for all the essentials of a man's wardrobe. The door mirror is conveniently near the tie rack. Below it is a unit comprising two handy shelves, a pocket for small articles, and another for shoe-cleaning materials. This has a heavy hinged front that drops on chains to serve as a horizontal shoe step

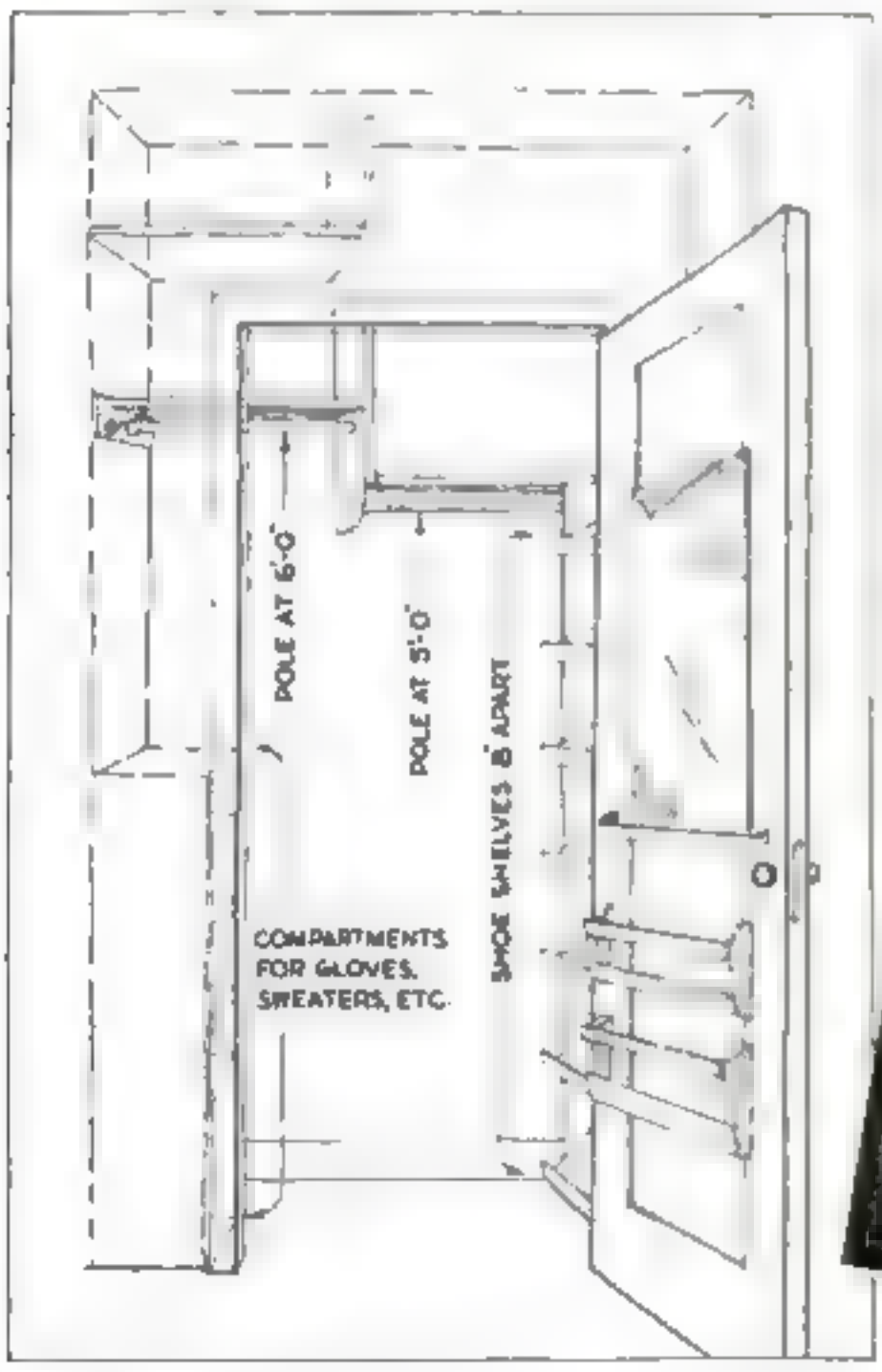
Planning Efficient Closets

TO SUIT YOUR FAMILY'S NEEDS

By Joseph Aronson
Interior designer and architect

CLOSETS need not be oversize to be efficient. A well-planned small closet may be more useful than a large one that is used in a hit-and-miss manner. Any moderately competent amateur craftsman can plan better-than-ordinary closets if he will take the time to analyze his own and his family's needs and the space at his disposal. Sketches of two good arrangements are presented here as a guide to such planning

The man's closet is ample to care for the currently used portion of an average wardrobe. A chest fitted into one corner opposite the door measures about 24" wide, 22" deep, and 30" high, and its four drawers are partitioned for socks, handkerchiefs, collars, and jewelry; pajamas and underwear; shirts in tiers, and sweaters. Over the chest hang coats and jackets. Trousers are hung separately in the space next to the chest.



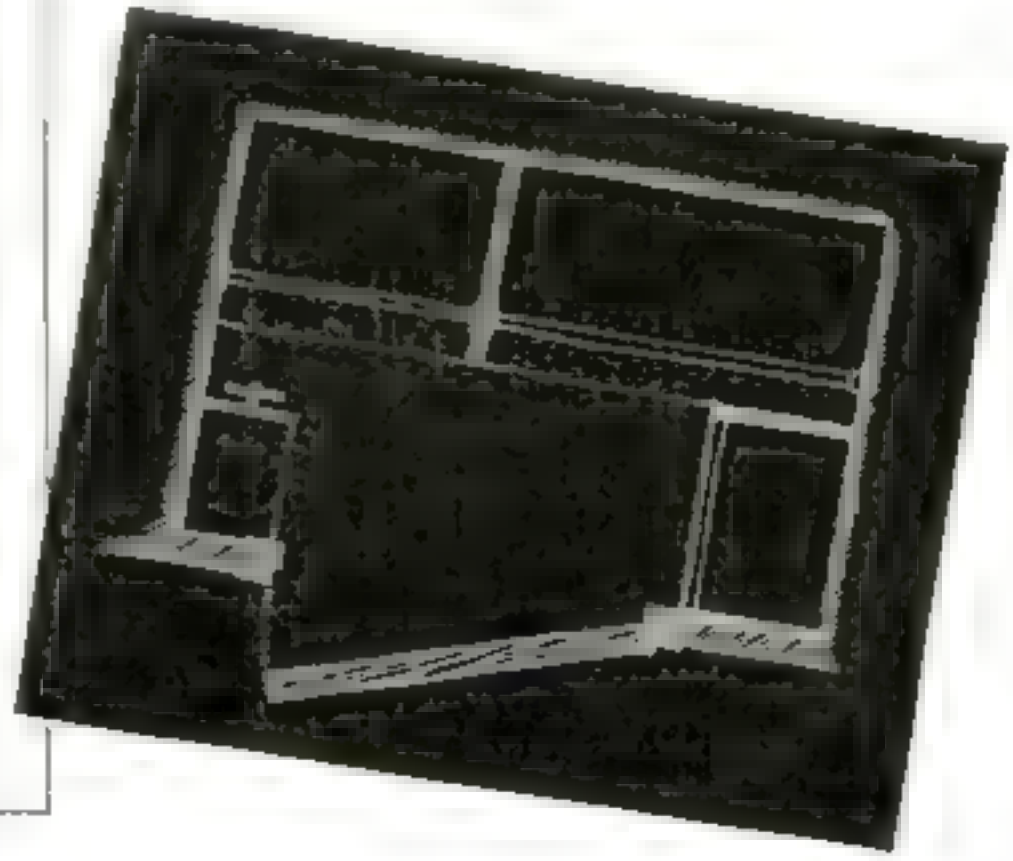
Shoe shelves are placed near the floor on the back wall. The large shelf, which is placed at a height of 6' on two ¾" by 4" cleats, carries two poles at right angles to each other. The shelf itself is used for hats, suitcases, and bulky articles. A few coat hooks are inserted in the cleats. On the door is mounted a mirror, a tie rack, and another fairly large rack, the lower panel of which swings down to serve as a shoe step.

The woman's closet has poles at two different heights, commodious shoe shelves, and racks attached to the door to hold pocketbooks. The shelves are about 12" deep, with a ¼" by 1⅛" strip on the front edges instead of a heel cleat such as is used in the man's closet. Space them about 8" apart.

Another narrower tier of shelves about 36" high accommodates gloves, sweaters, and articles of like nature. On the side of this, near the top, a small block is attached with a dowel passing through it, as shown. This is for hanging belts.

As in the case of the man's closet, a good-sized mirror may be fastened to the door if there are not adequate mirrors nearby in the room itself.

Fir plywood is actually as economical as good pine boards for chests, large shelves, and other closet fittings. Painted finishes are generally preferred in closets, although often a decorative effect is created by finishing the wood natural. Edges may be painted with contrasting color, or ornamented with narrow moldings, if desired. Egg-and-dart and so-called "rope" moldings are suitable for this purpose.



In half an hour a match flame can change the average home into an inferno, from cellar to roof. Early detection of fire saves life and property

Is Your Home Fire-Safe?

By GILBERT RAE SONBERGH

1 Keep chimneys in repair
2 Store things neatly in attic
3 Have rope ladders upstairs
4 Watch for deterioration of wiring and flexible appliance cords. Do not overfuse
5 Have smokepipes at least 18" away from joists and woodwork
6 Install several fire-detector units in cellar (a) and one at head of cellar steps (b). Put gong in upstairs hall (c)
7 Keep doors closed at night
8 Hang one extinguisher in the kitchen and another at the head of the cellar stairway
9 Have a fireproof door at the foot or top of cellar stairs
10 Keep a sand bucket in the garage

EVERY 90 seconds fire strikes at a home in this country. Every day, fires in homes claim an average of 19 lives and injure dozens of persons. At least half of these losses could be prevented, and whether your home will be on the casualty list of the future may depend upon what precautions you take today.

Most home fires are caused by carelessness, and the rest by neglect of dangerous conditions in electrical wiring and in heating plants. A periodic check-up of all danger points in your home will reduce by 75 percent its chances of going up in smoke. Such fire prevention is a real contribution to national defense, and one that every home owner and tenant can make at little or no expense.

There are three things to do to make your home fire-safe: First, check the danger spots where fire may start; second, fire-retard the basement; third, install a device to wake you the minute a fire does start. Many deaths occur through as-

phyxiation from gases long before the fire itself reaches its victims.

Defective heating plants are the biggest single cause of fires. Safety demands a yearly check-up of the whole system. See that all smoke pipes are at least 18" from any joists or other wooden parts of the house. Closer spacing may do no harm for as long as twenty years, but sooner or later critical conditions of heat and dryness will coincide and cause a fire. Pipes that are too close to wood should be moved.

In some cases it may suffice to apply a thick asbestos covering, but each installation must be considered individually, and no general recommendation can be made. Your fire department will probably be glad to send an inspector to give you professional advice, at no cost to you. "We'd rather spend an hour inspecting your home," said one fire captain, "than five hours pumping in water."

Accumulated gas in coal furnaces has been known to explode and throw hot coals out of the fire door. For this reason the space in front of the boiler should be kept clear of combustible material.

If you have an oil or gas furnace, your dealer will give it an annual inspection. There is no better form of fire insurance. It is a mistake to attempt adjustments, repairs, or alterations yourself. Oil burners are delicate mechanisms and should have the services of trained experts.

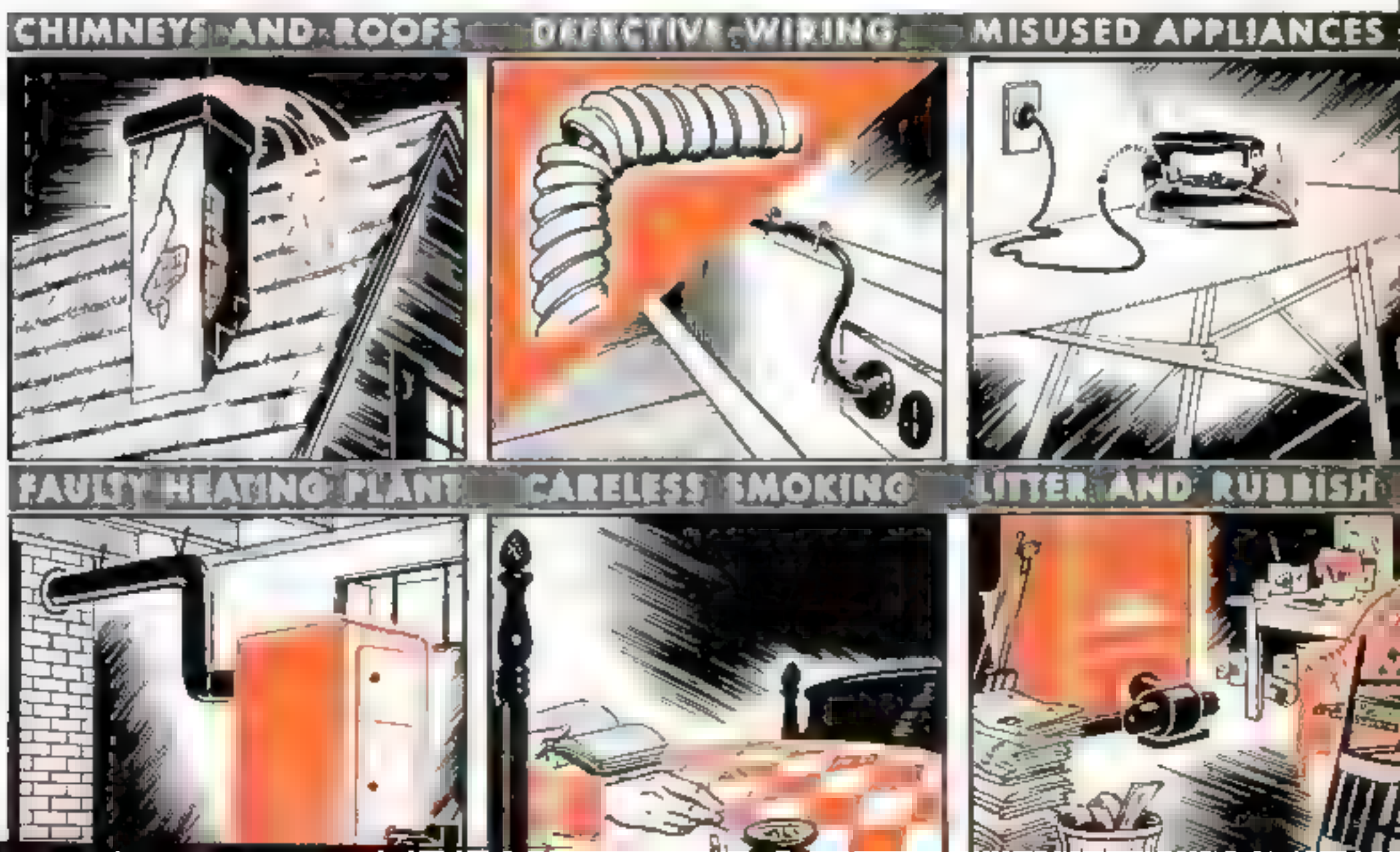
Chimneys should be cleaned and tested for leaks once each year. You can test your own by building a smudge fire in the furnace, then stopping the flue at the top. If wisps of smoke seep out into the first or second floor or attic, bricks are loose or mortar has cracked out and must be replaced. A chimney can be cleaned by lowering into it a brick loosely wrapped in a large cloth, but professional chimney sweeps can do a more thorough job.

If you have a wooden shingle roof, especially an old one, it is always possible for stray sparks from your own or a neighbor's chimney or from any nearby fire to start a blaze. Shingle roofs are now illegal in some communities unless special fire-retardant shingles are employed. All such roofs are much less likely to catch fire if painted at regular intervals with high-grade fire-retardant shingle paint. A man in White Plains, N. Y., burned leaves on a windy evening recently, went off to a movie, and unwittingly caused seventeen roofs to catch fire.

If your home is in a locality where lightning is frequent, it may be well to consider installing a good set of lightning rods. Well grounded rods will go far toward preventing fires from lightning.

Another potential fire hazard is electrical equipment. All appliances, motors, and ex-

SIX MAJOR CAUSES OF HOME FIRES



This cellar is fire-retarded. The plaster-board ceiling would hold back a fire long enough for the family to get out of the bedrooms and for firemen to save the rest of the house

tension cords should be checked regularly for frayed insulation, cracked or broken plugs, and loose connections. If your refrigerator has an old-style open unit, it may be well to install a six-ampere fuse at the motor. The writer once found a refrigerator in flames because a mouse had been snared between the belt and a pulley, thus stalling the motor, which promptly overheated. Sometimes a compressor seizes and stops the motor. Current enough to overheat the windings may not blow the house fuse, and a fire may result.

Electric wiring in old houses should be checked by a licensed electrician and any necessary changes made promptly. Millions of homes are unsafe by today's standards—one reason for our disgraceful annual fire losses. New wiring for any purpose must always be installed and inspected in accordance with local laws.

One of the most frequent causes of cellar fires is accumulated junk and rubbish. Few cellars are without their catchall piles of old furniture, clothing, rags, newspapers, and magazines. No one can say how many fires are caused by spontaneous combustion, which, incidentally, starts in a host of things other than oily rags. The ink on old newspapers has been known to start fires in this way.

The only remedy is to clean out such dangerous rubbish. Nine tenths of the things so saved will never be used, and should be thrown away. The remainder should be stored in accordance with safe practice. All paint-smeared or oily rags should be washed out and hung in the open to dry or kept in sealed metal containers. Stacks of paper are easy to dispose of now, when paper shortages are upon us. Furniture should be spaced out, not piled up against the joists. The same precautions apply to attics, which are often as bad as cellars, and must be cleaned out if homes are to be fire-safe.

Fire-retarding your basement will, if a fire occurs there, keep it confined until the family can escape and the fire department can put it out. The most essential thing is a 2" thick metal-covered door, preferably at the foot, otherwise at the head of the cellar stairs. It should be self-closing and ought to open inward, toward the cellar. The standard door at this strategic point won't withstand the terrific heat and the pressure of hot gases caused by a cellar fire.

Another excellent way to fire-stop the cellar is to cover the ceiling with metal lath and cement plaster, or with asbestos board. You can do the job yourself at a saving. With the ceiling so covered and a thick door between the cellar and the rest of the house, a fire will smolder for a while and can be put out easily.

Some houses are constructed with hollow spaces in the walls that run from cellar to attic. In a house of this kind, a fire starting in the basement can spread up through the walls in an amazingly short time. As a remedy, fire stops of incombustible material should be installed between the studs in the walls at the floor levels.

Among careless personal habits causing fires are use of gasoline or other inflammables for cleaning clothing in the home, leaving matches where children may reach them, and that bugaboo, smoking in bed.

Most people will recognize the danger in the last two, but few may realize that gasoline, benzine, and naphtha, vaporizing very quickly, combine with air to form an explosive mixture which may be set off by a tiny flame or spark, such as the flame from the pilot light on a gas stove and even a spark from static electricity developed by swishing clothing around in the cleaning fluid. The best prevention in this case is to avoid inflammable cleaning fluids.

Fires are frequently started by nonautomatic electric irons left on while the user is attending to other duties. These have no thermostatic unit to shut off current when they reach operating temperature.

Open fireplaces are also a hazard unless they are protected by fire screens, for sparks flying out can set a rug ablaze. No fire should be left burning brightly in the fireplace when the family retires or all leave the house, and if the screen is not one that covers the opening completely, the fire should be extinguished altogether.

If a fire should occur in your house, you want to know about it at once. Immediate discovery will save lives and go a long way toward saving the house. Excellent fire alarms can be had for from five to twenty dollars. Most of them are set to go off at 150 or 165 deg. (a temperature reached very early in the life of a fire) and are guaranteed to wake the whole block. You can also make your own fire alarm from a discarded auto thermostat (see P.S.M., Apr. '39, p. 196). If carefully made and tested every six months, it should be quite dependable. A dog in the home is a fairly good fire alarm. His keen sense of smell will usually wake him before the gases reach asphyxiating density.

Every home should have at least one fire extinguisher. Many fire-department officials say the 2½-gallon soda-acid inverting type is best for all-around use. In the kitchen, a supply of ordinary baking soda should be on hand to snuff out grease and other kitchen fires. It is also a good idea to keep a length of garden hose in the cellar, permanently attached to the drain cock of the hot-water tank or other water outlet. Call the fire department, however, before fighting the fire yourself.

Even if you take all the precautions mentioned, your family ought to know how to get out. The value of periodic home fire drills cannot be overemphasized. You should sleep with all bedroom and other doors latched. Keep rope ladders in upstairs bedrooms, unless the occupants are trained to get out by knotting sheets together. If a fire reaches the first floor, it will be impossible to live more than a few seconds in the upstairs hall. If it is still in the cellar, it may be possible to get out the front door, but the utmost care must be exercised in opening your bedroom doors. *If they are hot to the touch, don't open them!* If not, brace the door with your foot and shoulder and open only a crack at first. If you feel heat and pressure, slam it shut and escape by the window. Remember that nobody is likely to live if he opens a door that is under pressure.

Close the doors, but leave windows open. When you get out, never go back for anything. Summon the fire department and leave everything to the firemen.

SIXTEEN SAFETY HINTS

Keep matches away from children.

Never leave irons or other appliances turned on except when they are in actual use.

Use no larger than 15-ampere fuses.

Keep dusting cloths in a metal box or can.

Never use inflammable fluids for dry-cleaning.

Don't hang electric cords on radiators or other metal objects.

Never hang clothes on extension cords.

Let irons cool before putting them away.

Don't use matches or candles to hunt in closets.

Don't empty ash trays into wastebaskets.

Don't smoke in bed.

Don't hunt for gas leaks with a match. Brush soap lather on suspected joints and watch for bubbles.

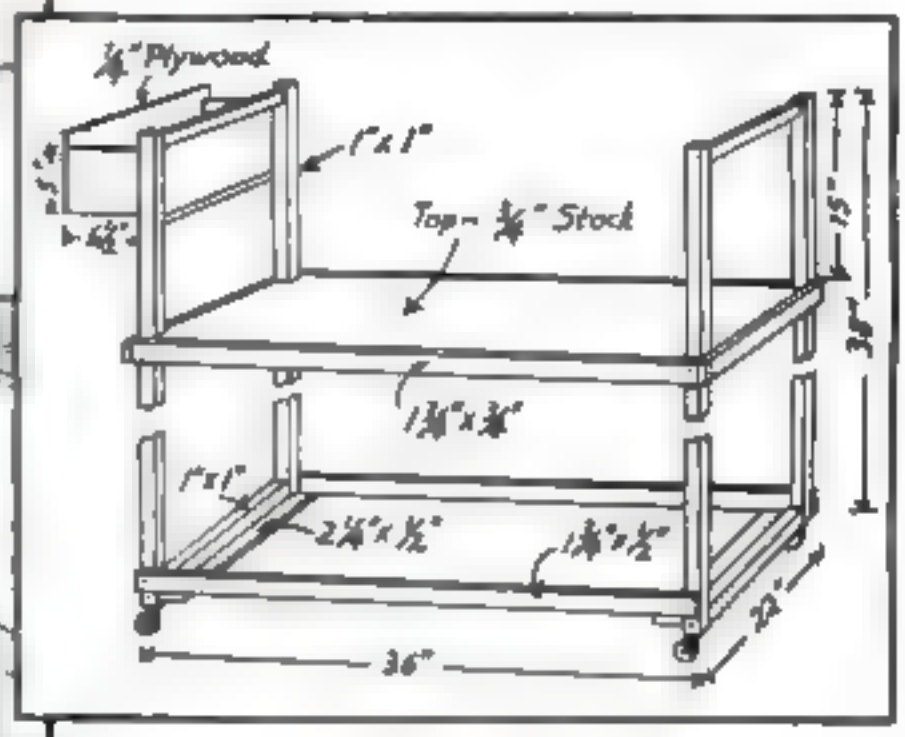
Never leave a fire in an open fireplace.

Use no inflammable insect sprays indoors.

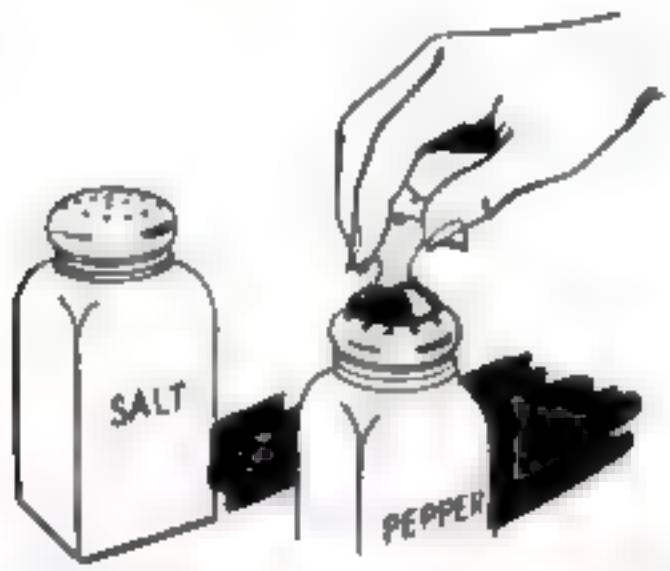
Leave the vacuum cleaner out of the closet for ten minutes after using it.

Never leave young children alone.

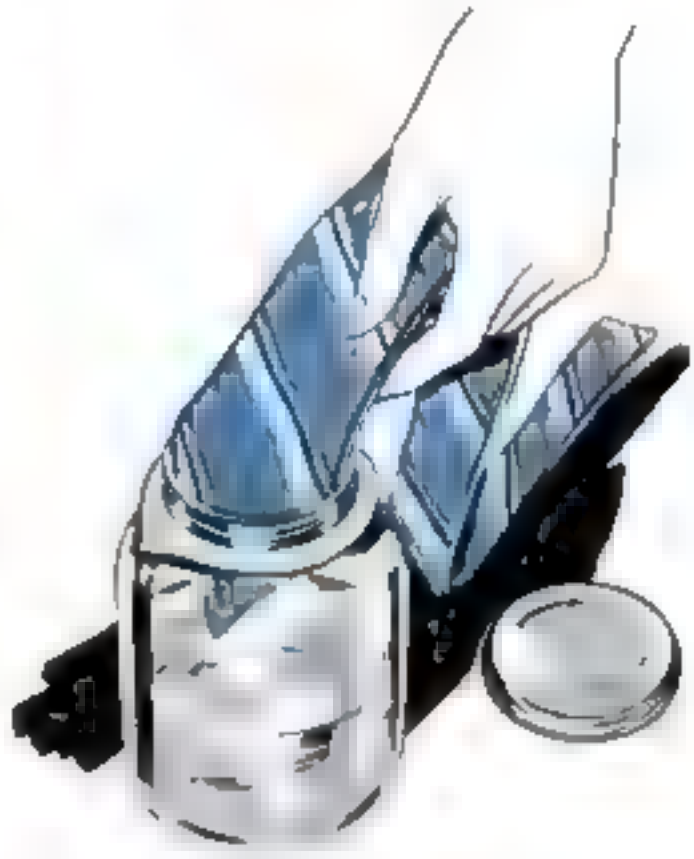
KEEPING



Back-bending in transferring laundry from tubs or washing machine to a basket, and to and from the line, is lessened if a light wooden dolly with casters, clothespin tray, and handles is used. The table level should be a convenient height. Wheels will serve on the lawn better than casters

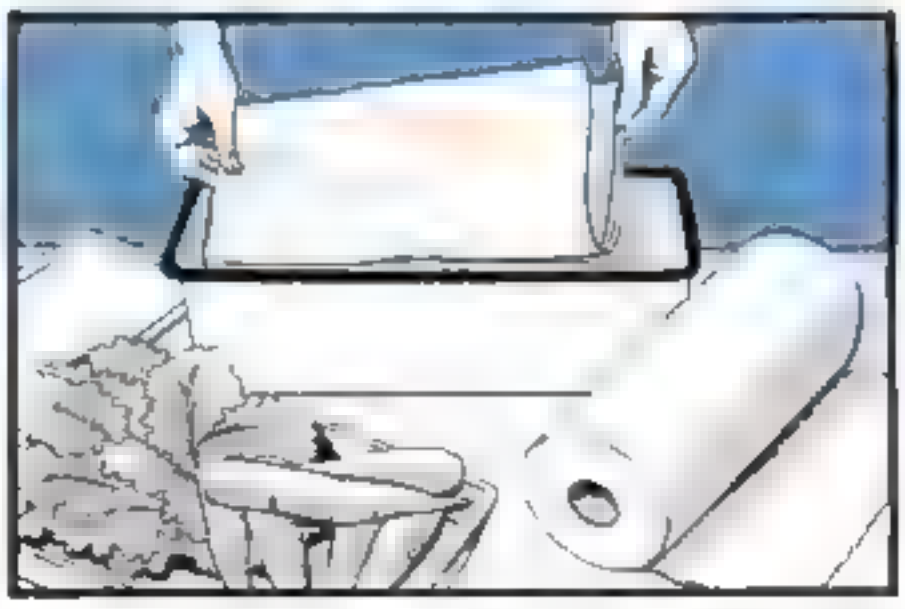


Forced up and down on the clogged top of a salt, pepper, or spice shaker, a small suction cup will clean out the holes far quicker than a toothpick



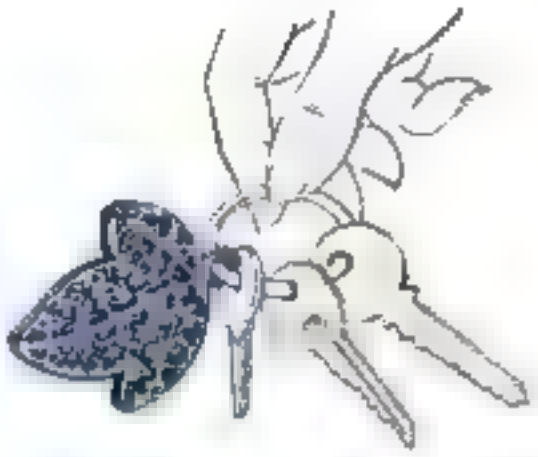
Small pieces such as ties, lace, and ribbon can be dry-cleaned in a fruit jar to save cleanser. Put the article in, cap the jar, and shake well

When food being cooked needs frequent stirring, snap a spring-type clothespin on the edge of the pot for a spoon rack. This will prevent dripping



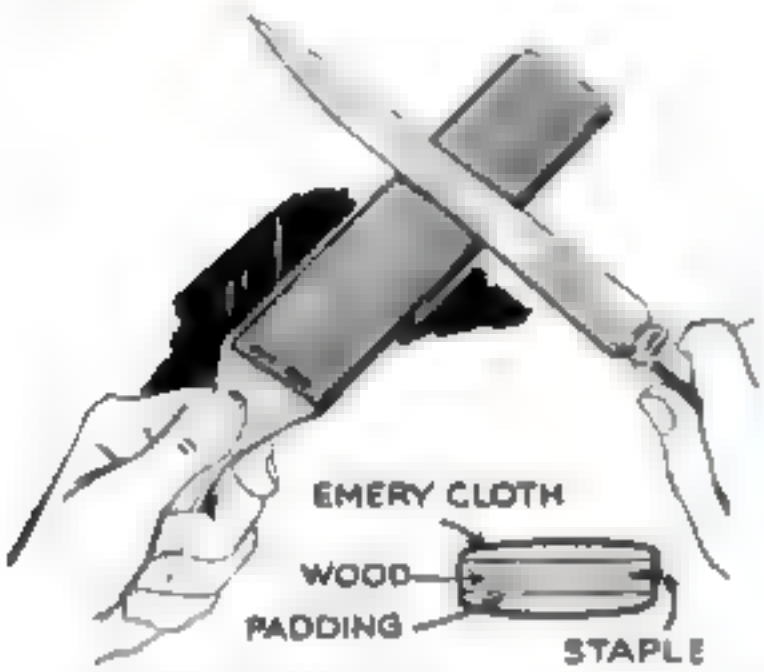
Paper towels on the bottom of the refrigerator's vegetable hydrator will absorb excess moisture, retard leaf rust, and keep the container clean

THE HOME SHIPSHAPE

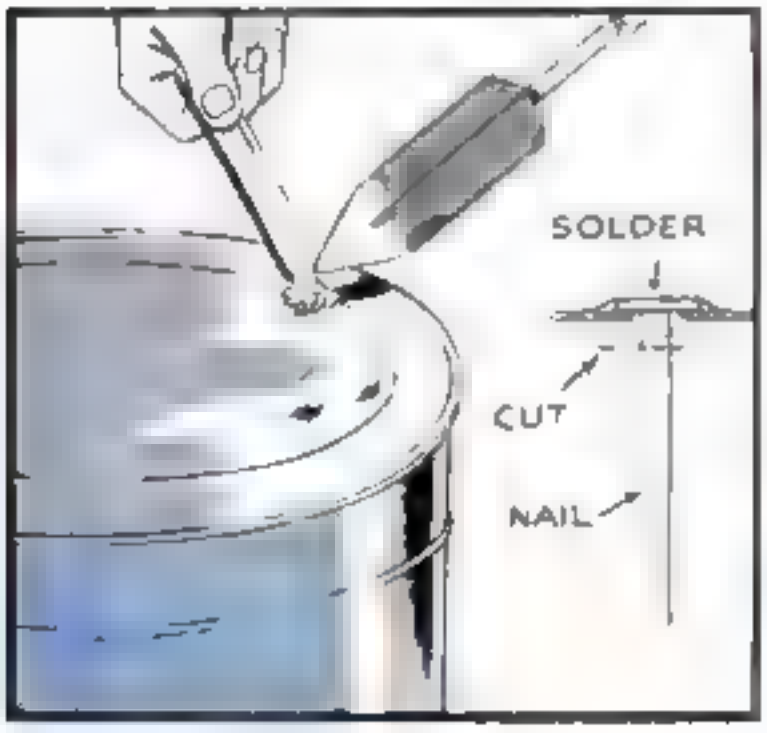


Dropped keys, even on the littered floor of a shop or barn, or in grass or weeds, can be found quickly if a bit of brightly colored plastic from an old piece of costume jewelry is attached to the ring

For the caulking needed occasionally about the house, a serviceable gun can be made from a screw-handle grease gun and copper tubing. The threads of the steel barrel will cut threads on the tube The end of the tube is bent at an angle and squeezed almost shut, or filed as shown

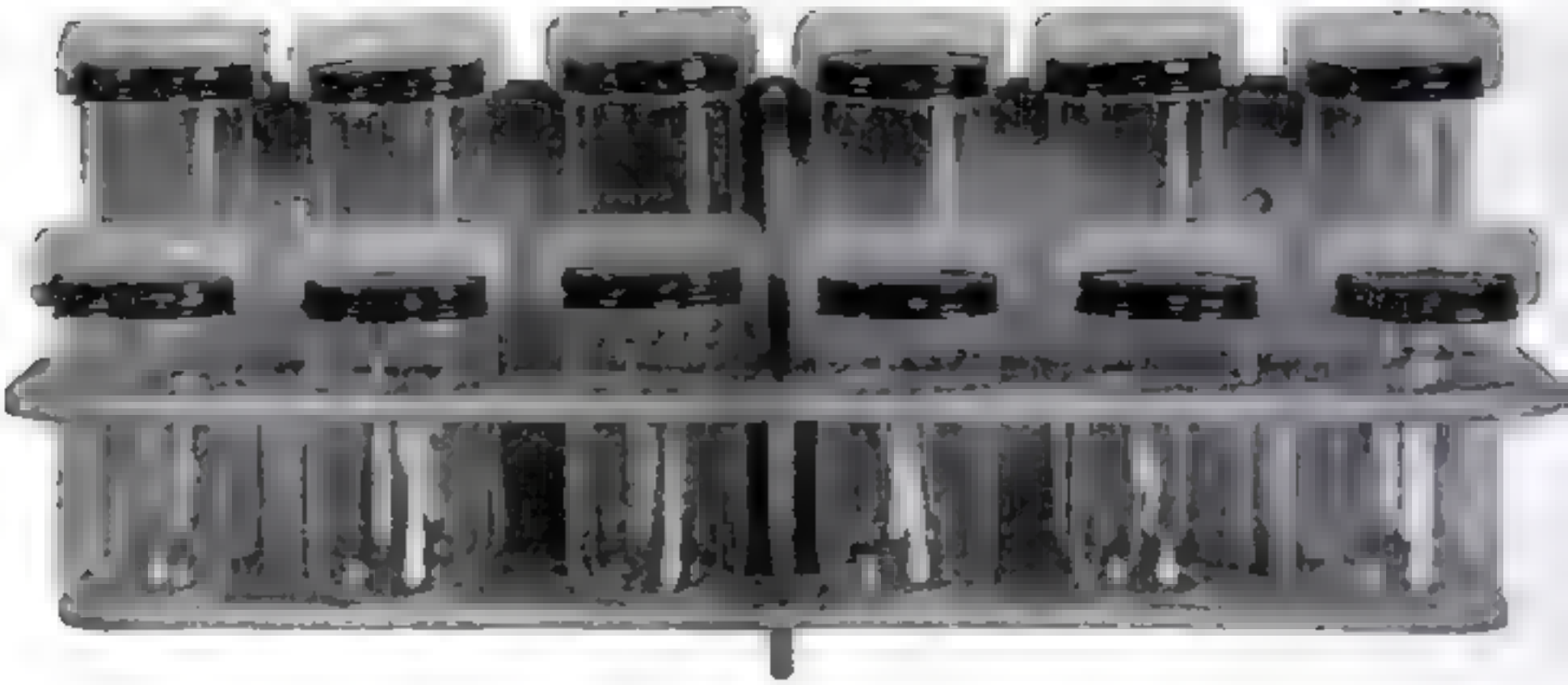


Emery cloth over cotton or other padding on a light, wooden paddle is an efficient knife sharpener. Use medium cloth on one side, fine on the other. Sew or staple the edges together, and coat them with shellac



Small holes in stove tanks, buckets, oil cans, and the like can be patched quickly by inserting a short nail or escutcheon pin and then soldering from the head side

Lawn seeding is simplified if 10′ squares are marked by snapping a lime-dusted line. Weigh the seed needed for 100 sq. ft. and mark its level on a container. Shake it through a strainer, or mix with fine sand and sow by hand



Spice Shelf and

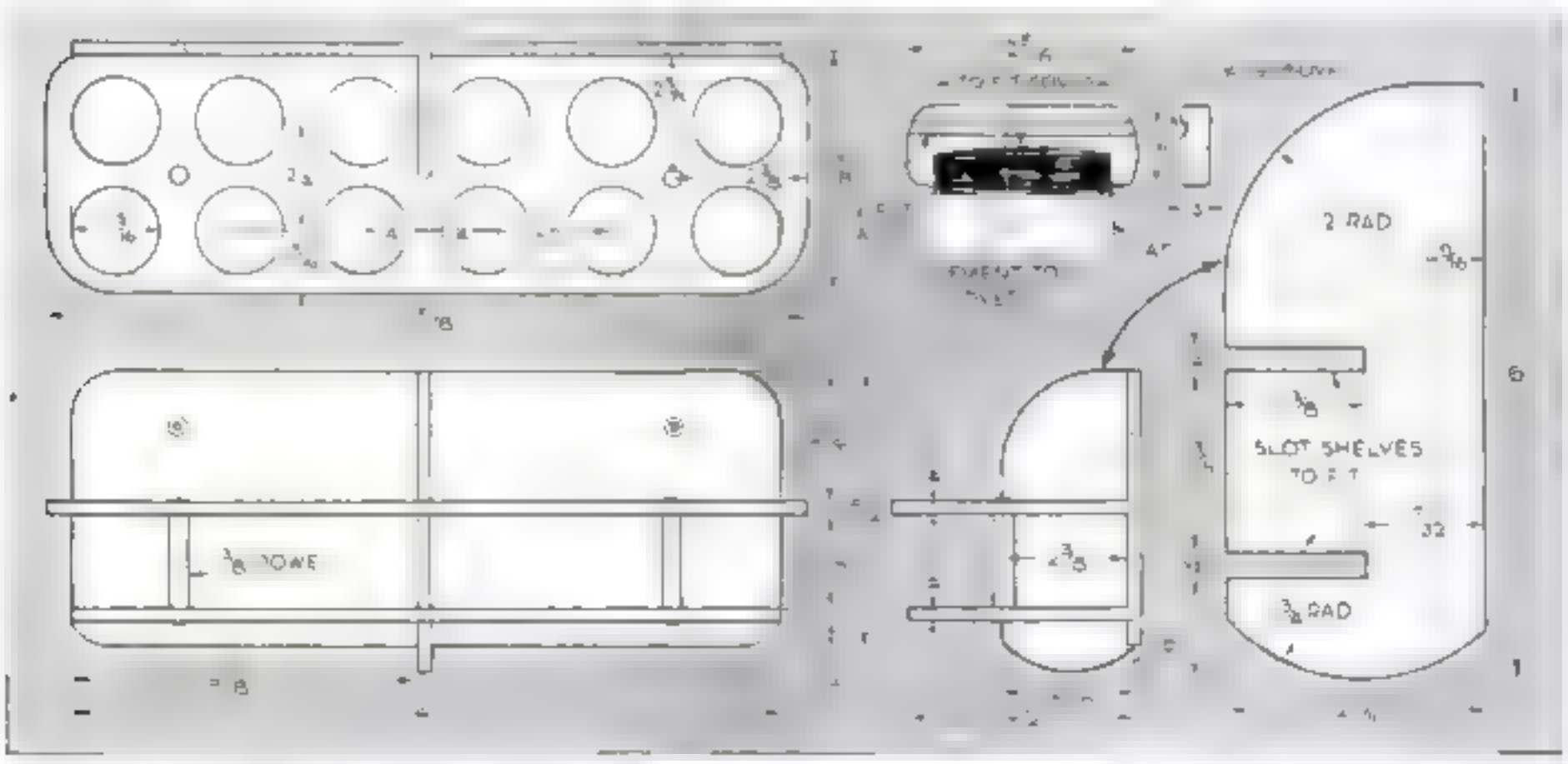
DESIGNED BY

PLYWOOD scraps left over from large projects can be used to advantage in making the two very practical articles shown on this and the facing page.

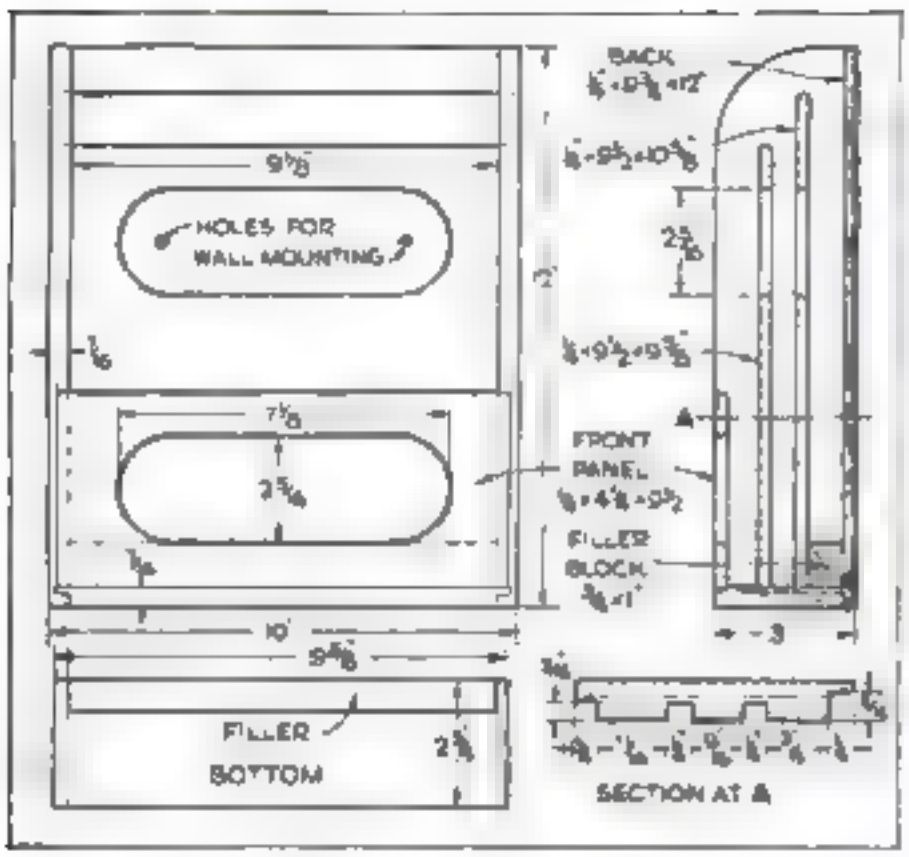
KITCHEN SPICE SHELF. A miscellanous collection of spice cans and jars is always hard to keep neat, but spices kept on this shelf are quickly selected, and the transparent containers make it easy to tell when the supply of any one is running low.

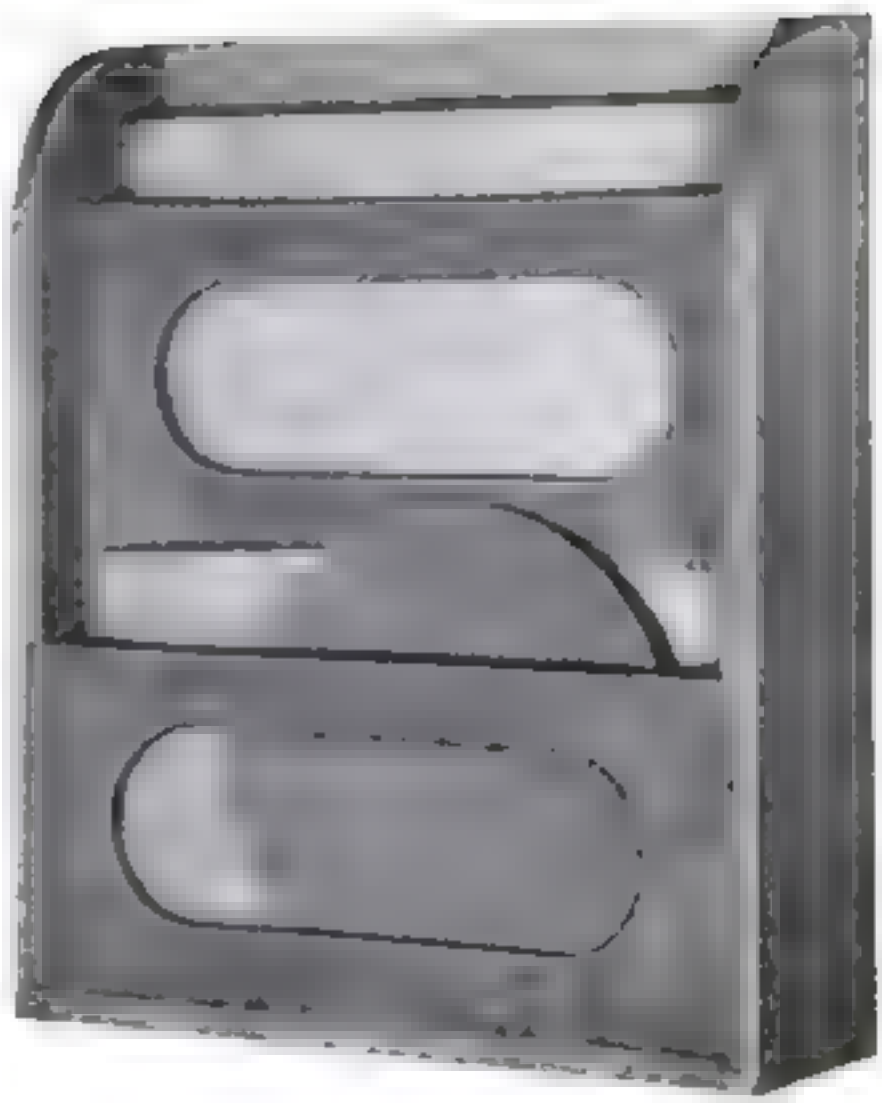
All parts are ¼" plywood. The two shelves are notched at the back to form half-lap joints with the upright at the center, and are dadoed ⅛" into the back. Either celluloid jars like those illustrated or small screw-top glass jars may be used. Cut the holes to fit them, either on a jig saw or with a circle cutter. Sand smooth the inside edges on a drum chucked in the lathe or the drill press.

Taller jars may be used in the back row, or the label mounts may be made larger so that they project above those in front. The groove for the labels is formed on a long strip and the individual mounts are then cut off and shaped to fit the covers. Assemble the shelf with glue and brads. Finish in any preferred manner, or by rubbing gray paint into the wood, and waxing afterward. Approximate time, 5 hours.



Mayonnaise jars will serve instead of the unbreakable ones shown above if the holes are cut to fit. If two sizes are not available, insert a filler strip to hold the rear row slightly above the front





Sandpaper Rack

ERNEST R. DEWALT

SANDPAPER RACK. This convenient shop accessory may be hung on a wall, stood on the workbench, or laid flat on a shelf. Accommodating standard sheets of abrasive paper and cloth, it prevents curling, and keeps coarse and fine grades separate. The front compartment holds quarter sheets and disks; the back one has a filler block to lift the sheets slightly above those in front.

In the rack shown, the sides and bottom were made of 7/16" stock, fitted together with rabbeted dado joints. The sides are also routed 3/16" deep for the ¼" plywood partitions, rabbeted for the back, and stop-rabbeted for the short front panel. Cut the bottom ¼" narrower than the sides, letting the back extend across its thickness.

The cut-outs in the three partitions are all jig-sawed in one operation while the parts are tacked together temporarily. Sandpaper the inside edges smooth, make a trial fitting of the parts, and assemble the rack with glue and ¾" brads. Stain or paint it to suit. Approximate time, 4 hours.

CLEANING MARBLE [FORMULAS]

To clean marble ornaments, table tops, fireplace trim, and other badly soiled marble, mix the following with a little water to make a paste. Be sure the water used is soft; if it is not, add a softener.

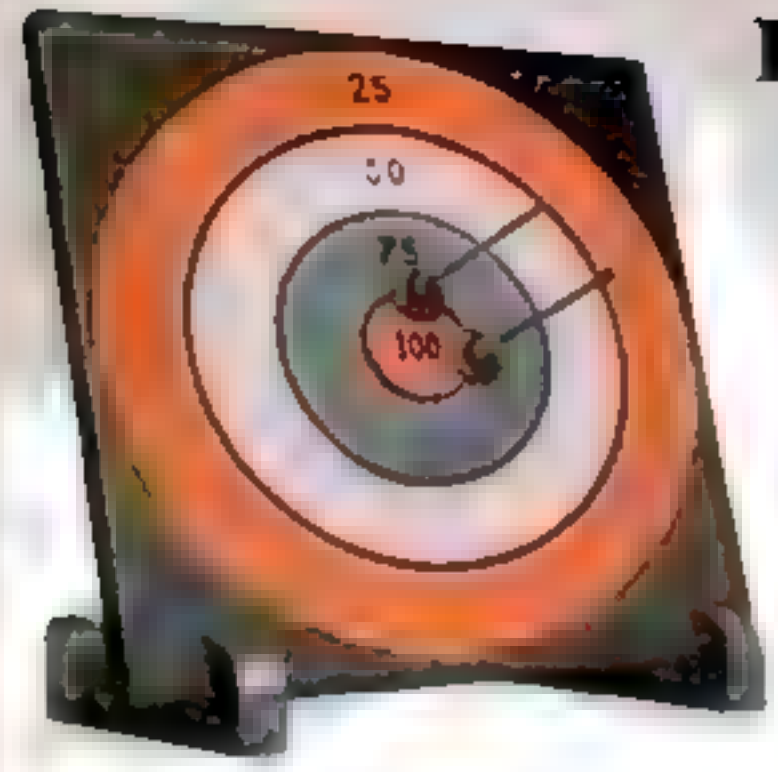
FFF pumice stone	1 part
Baking soda	2 parts
Spanish chalk	1 part
Soap powder	1 part

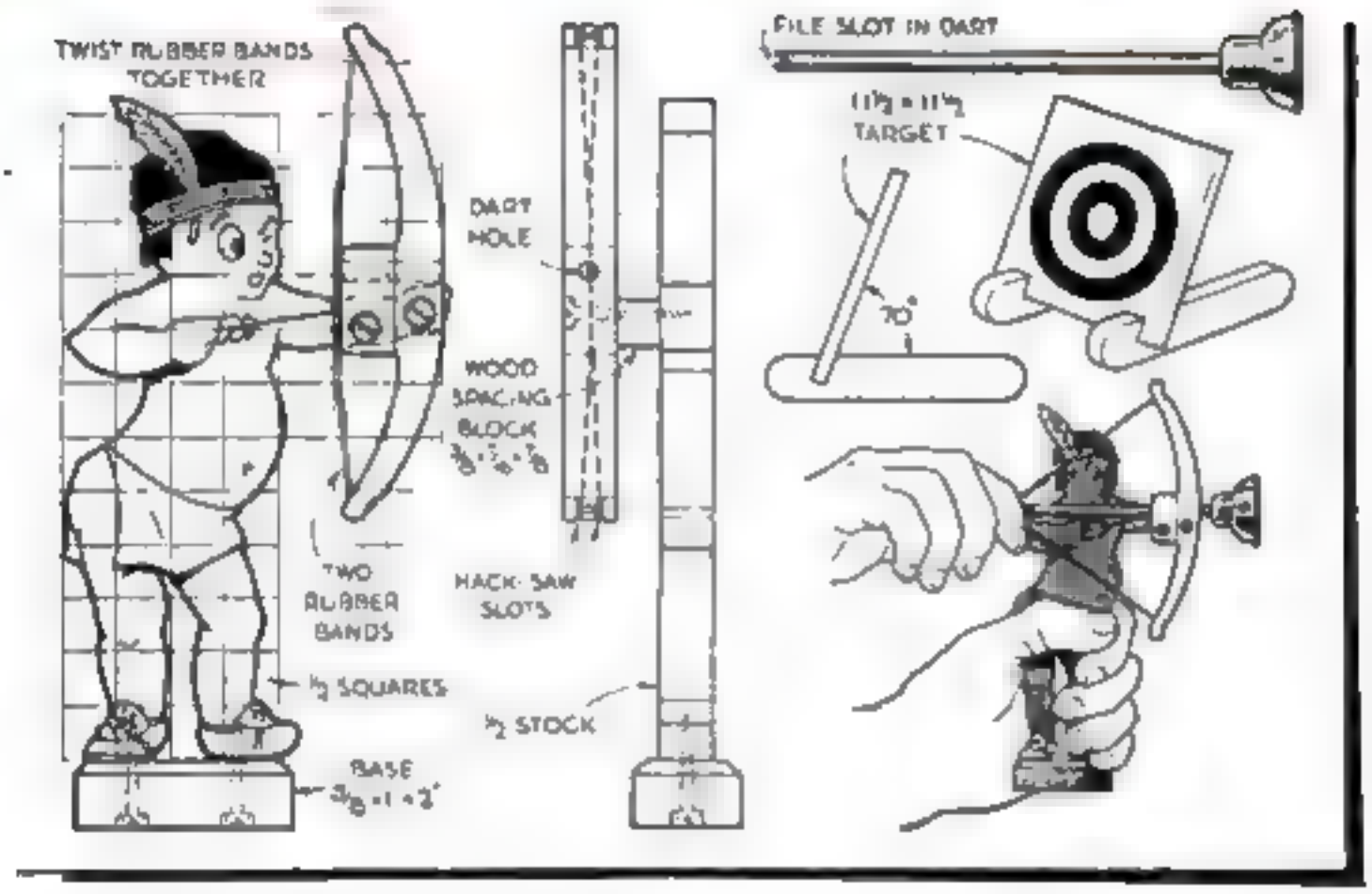
It is important to rinse the marble with plain soft water before applying this paste. Put a little on a moistened cloth pad and rub gently until the marble is clean. Sponge off thoroughly and wipe dry.

Any cleanser containing an abrasive such as pumice stone may, however, dull very highly polished marble. For a surface of this type, a pure white soap dissolved in soft water and used on the marble only after a preliminary dampening with *soft* water is the safest cleaning agent. Use only soft water for the final rinsing. Javelle water diluted with four times its volume of water will remove some stains from marble. A preliminary rinsing with plain water, and thorough rinsing after the use of Javelle water, are important. Rinse and dry immediately any metal fixtures with which Javelle water has come in contact.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

Hiawatha Junior Target Game





"Bull's-eye!" whoops Hiawatha, or rather, two bull's-eyes, and with him whoops the whole family. This little target game is designed primarily for children, but it will find equal favor at parties for grown-ups

By MYRON FLEISHMAN

Toy and Game Designer

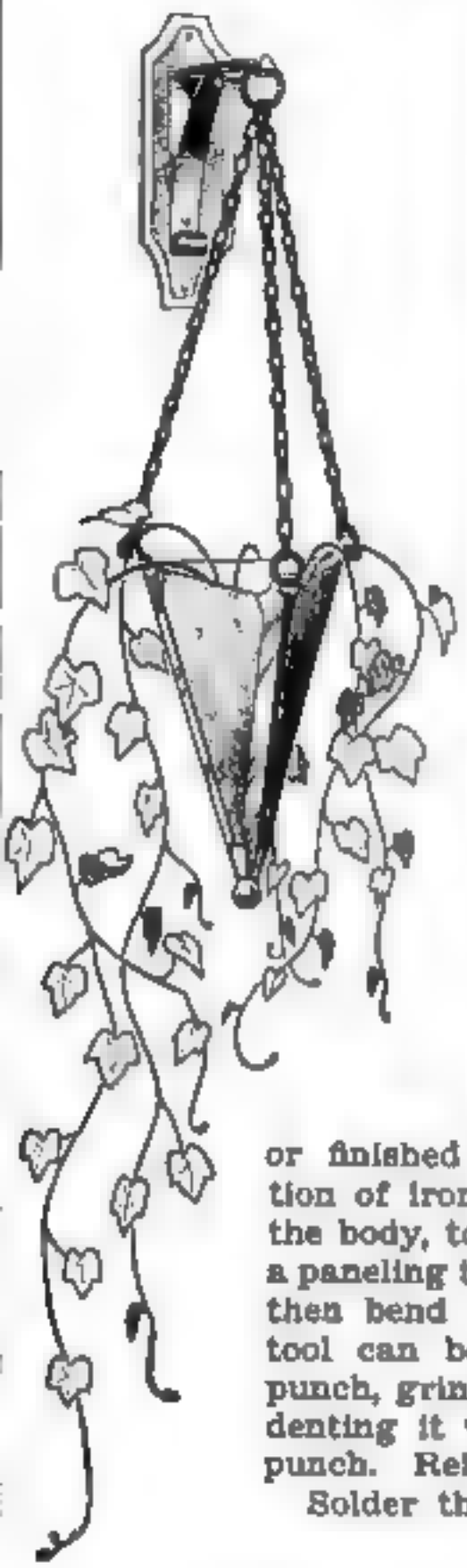
HERE'S an amusing little target game for Dad to make for Junior—and it will be double fun for Dad. Junior will just have to wait his turn to play with it after it's made, and even then he'll be lucky if he can get it away from the grown-ups at all!

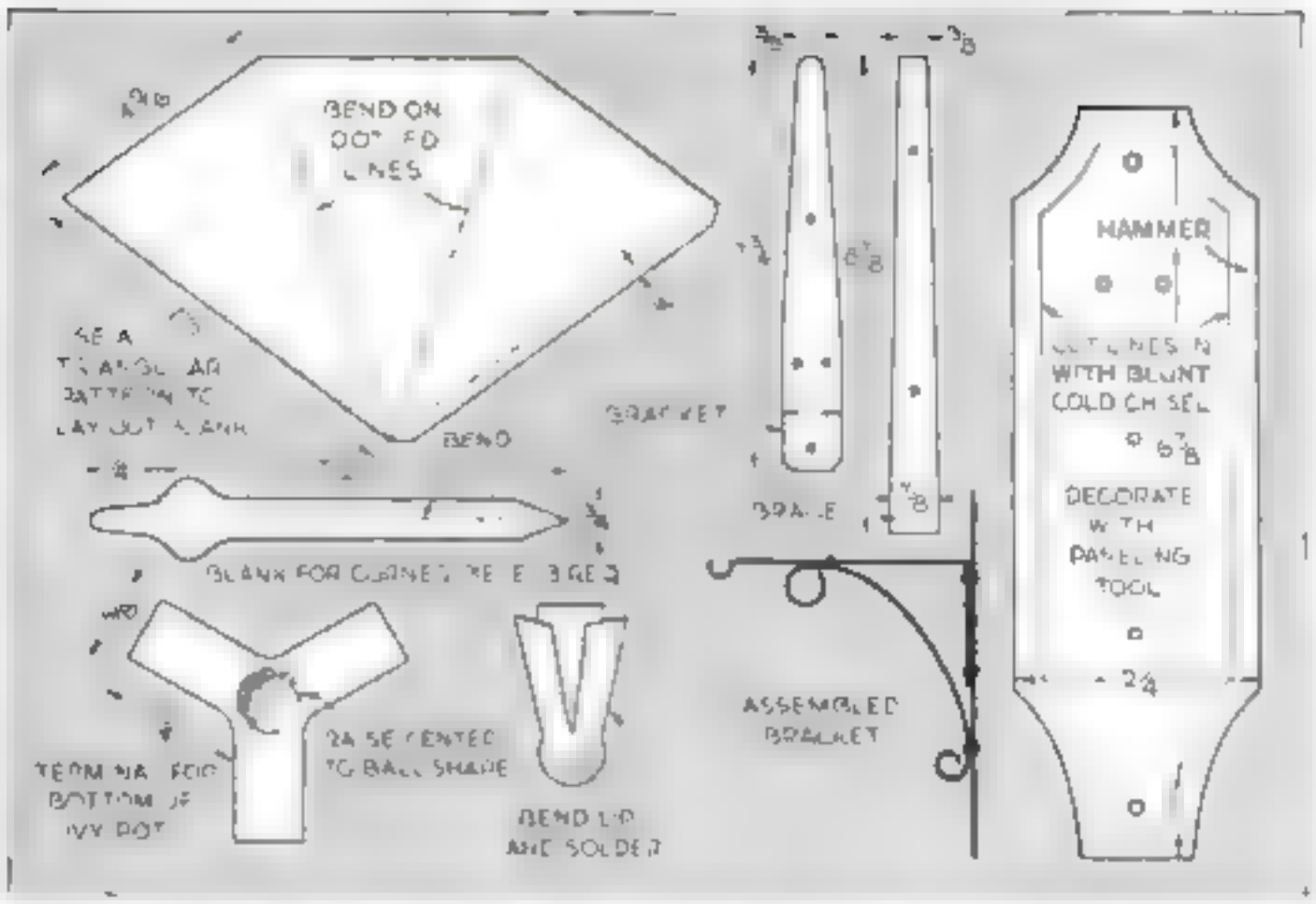
Each contestant stands about seven feet from the target, holds the Indian figure in one hand, and shoots three suction-cup darts in turn from the bow. This is done by inserting the stem of the dart through a hole in the bow and drawing it back against a bowstring made of a couple of rubber bands. When released, the "arrow" is propelled with surprising force and accuracy. If a dart sticks on one of the lines instead of in a numbered space, the higher of the two adjacent numbers is scored.

The Indian figure and the bow are laid out by means of ½" squares and sawed from ½" thick wood. Drill the dart hole in the bow just large enough to allow the shaft to pass through. Assemble the parts as shown after rounding the edges and sanding all smooth. Two 1¾" rubber bands are used on the bow. Loop one end of the bands through the upper slits, twist the free ends so that the bands cross in the center, and catch them in the lower slits.

The target is ¾" by 11½" by 11½". It is mounted on two pieces ¾" by 1¾" by 8", which are slotted as indicated. They are left unattached so that the target can be taken apart when not in use and stored away conveniently.

Paint the Indian figure and the target as shown, sanding between coats and using particular care to obtain a smooth surface on the target so the darts will stick readily. A natural color can be obtained on the Indian by using red mixed with a little yellow.





Ivy Pot and Bracket Shaped from Tin-Can Stock

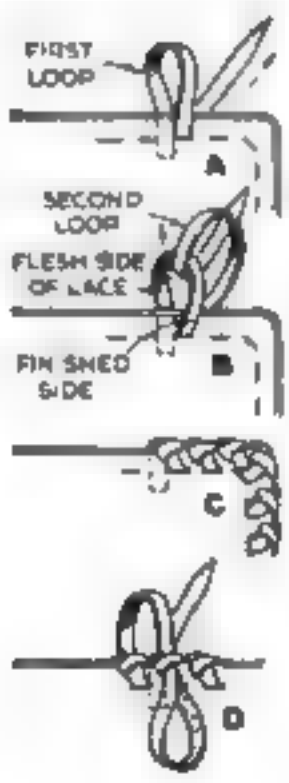
THE ATTRACTIVE wall ornament shown can be made from tin-can metal and gilded, lacquered, or finished a dull black in imitation of iron. Cut out the blank for the body, tool it on the outside with a paneling tool or background punch, then bend it to shape. A paneling tool can be made by annealing a punch, grinding the end flat, and indenting it with a chisel and center punch. Reharden it if practicable.

Solder the seam on the inside to make it water-tight. Shape and solder in place the three corner pieces and also the ball-shaped bottom terminal. Cut out the parts for the bracket from the same tin-plate stock, tool them as shown in the drawings, and then rivet them together.

Both bracket arm and brace may be made double thickness for greater strength.

The three chains can be purchased or else made by winding fairly thick wire around a ⅛" by ⅜" iron bar and sawing the tube so formed parallel to the bar to make individual links. Paint the inside of the pot with asphaltum varnish.—DICK HUTCHINSON.

EDGE LACING—BUTTONHOLE STITCH [LEATHER CRAFT—10]



The buttonhole stitch covers the edges better than does the whip stitch. Prepare edges as for the latter (see Leather Craft—9). Cement one end of a yard of lace between the edges as at *A*. Hold finished side of leather toward you, lacing from left to right. Bring lace over edge and insert in first slit. Pull through to form first loop. Bring lace over edge and push through first loop away from you as at *B*. Tighten first loop. When tightening second loop, press thumb of left hand over stitch. Bring lace over, insert in second slit, and repeat the two steps to form the second stitch. Round corners as at *C*. Finish lacing as at *D* by inserting lace down through the second loop of the first stitch, then through the first slit. Cement and tighten lace, then cut off surplus.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

NEW TRIM ADDS COLOR TO ANY DRAB HOUSE

Appearance can often be changed completely in a home as well as a person by attention to details. Repainting trim and sash is the least expensive and one of the surest ways to achieve striking results

Color Styling Your House

HINTS ON PAINTING EXTERIOR TRIM

By MAURICE WHARTON

WITH the advent of spring, the home owner becomes more conscious than ever of the appearance of his property. While his house may not require an entire new paint job, attention to the sash and trim will enhance its attractiveness and give added weather protection to vital areas.

Outdoor painting may be undertaken at any time in dry weather if the thermometer registers 40 degrees or above and there is no danger of its going lower before the paint is dry. If painting is done at a lower temperature, the coat may remain soft so that it will catch soot, become dull, and possibly wash away. Except when the weather man plays tricks in northern sections of the country or the season is unusually rainy, springtime provides suitable atmospheric conditions, especially as the sun has not yet achieved its blistering power and insect pests, which mar many a paint job in the summer, are still absent.

Color styling plays an important part, and there is a definite trend toward contrasting shutters, doors, and window trim—with particular emphasis on red, blue, and

dark green. In this connection the two tables of color-styling suggestions on this and the following page may be helpful. A change of trim and sash color, done conservatively, may give a face-lifting to the old homestead and change a wrinkled countenance into a gracious smile of hospitality.

Those who are not afraid to experiment can work out all sorts of novel effects. For example, a small white house can be framed in color by painting the butt ends and edges of the shingles at eaves and gable a dark bronze green, trimming the white chimney with a band of bronze green at the cap, and coloring the inside top and sides of the window recesses and door frames bright grass green, but leaving the face of the trim white.

It is important to choose a trim color that will not fade. Trim paints usually have a higher varnish content than ordinary exterior paint to give a more glossy surface. In testing paint on a surface to be covered (which is wise, as paint has a tendency to look darker than the color on a sample card), cover a foot or two rather than a small space and look at it from a distance. Very light tints, especially, need such testing

Many a job is ruined before a brushful of paint is applied because the surface is not properly prepared. If the old coating is thin but fairly smooth, all that is necessary is to dust off well and putty up the cracks, nail holes, and joints. Patches of blisters must be scraped and touched up with paint. Roughened area should be lightly sanded. If there are a number of coats of paint, usually the case with an old dwelling, these should be thoroughly scraped, or burned off if necessary, otherwise the new paint, lacking a satisfactory base, will appear uneven and may peel off.

The wood must be thoroughly dry, inside and out, or the sun may draw moisture to the surface and cause blistering. Also, do not neglect the backs of ornamental shutters. True, it requires time to take them down, paint the backs, and put them up again, but it is time well spent. Moisture will get into an unpainted exterior surface, and the sun will draw most of that moisture out through the part of the surface that the sunlight hits, cracking the paint in the process.

The chances are that metal sash has begun to rust, and if this rust is not removed or neutralized, it is likely to continue to make trouble, even after repainting. The safe way is to remove or neutralize the rust and apply paint of a type prepared especially for use as a first coat, over which any good finish paint can be applied. There are many rust-inhibitive paints and metal primers on the market, including red lead and blue lead sulphate, both of which come ground in oil, the same as white lead in oil. Use special metal-sash putty for metal sash, and ordinary glaziers' putty for wood sash.

If the sash is wood, there will be no rust, but there will be dirt and perhaps scaling paint, as well as places where the putty has become loose. It is not much trouble to remove the dirt, but sometimes the removal of the putty is difficult. *(Continued)*

Good Style in House Painting

Based on recommendations of the Council for Paint Styling of the National Paint, Varnish and Lacquer Association

TYPE OF HOUSE	TRIM	SASH	SHUTTERS	DOORS
Colonial with light body color and medium to dark roof	Lighter* than body	Same as trim	Different from other colors, and darker	Same as trim
Large cottage with light body color and medium roof	Lighter than body.	Same as trim	Different from other colors	Different from other colors or same as trim
Small cottage with light body and medium roof	Lighter than body	Same as trim	Different from other colors	Different from other colors or same as trim
English with light body color and medium to dark roof	Darker than body	Same as trim		Different from other colors
French with light body color and medium to dark roof	Lighter than body	Same as trim	Different from other colors	Same as trim
Spanish with light body color and bright roof	Darker than body	Same as trim or door		Different from other colors
Modern with light body color and dark roof	Darker than body	Same as trim		Different from other colors

*If the body color is white, the trim should be white also.

To soften putty around window glass for easy removal, a large soldering iron—one such as tinners use—is helpful if heated and drawn over the putty. In just a moment the putty should be softened so that it can be removed easily with a putty knife. It should be borne in mind, however, that heat, if carelessly applied, may cause the glass to break.

Before the new putty is put on, it is well to apply a coat of paint or shellac to the wood that will be covered by the putty. This is to prevent the porous wood from absorbing the oil from the putty, leaving it to dry out and fall away. It is possible to apply paint as soon as the new putty becomes skinned over, but it is best to wait until it is thoroughly dry. A coat of any good exterior paint may be used and a second coat put on, if necessary, as soon as the first is dry.

Unless care is exercised in painting, it is possible to have the sash become so securely cemented to the runs that the glass may be broken in the effort to get the sash to move. To prevent this, it is a good idea to move the sash up or down an inch or two occasionally while the paint is drying.

Gutters and down spouts are important. If they are not well cleaned and painted, they will soon begin to deteriorate; and when they leak, the woodwork decays and expensive repairs are soon necessary. Be particularly watchful for signs of decay in the steps and in the bases of porch columns, which may require repairs.

Copper stains or discolorations from screens, gutters, valleys, down spouts, and flashings occur when copper salts, formed by moisture and gases in the air, are washed down over the painted surfaces by rain. Some pigments are more affected by copper salts than others. It is comparatively easy to remove the stain in some cases (a good rain often washes it away), yet impossible in others, for it becomes fixed in the film. To prevent this, paint or varnish the copper surfaces—every two years if you want to be certain that the coating will constantly keep salts from forming.

Before painting, new copper screens should be cleaned with gasoline or benzine to remove all traces of dirt and grease left by the makers, and old ones should be brushed with a medium-coarse scrub brush to remove all dust. As much as one quart of turpentine should be added to each gallon of spar varnish for both first and second coats on copper screens. Care should be exercised to see that the varnish is well brushed out so that the mesh of the screens is not filled up. Paint for screens also should be thinned with turpentine so that it can be applied without filling the mesh, unless a prepared paint made especially for screens is used.

Color Accents

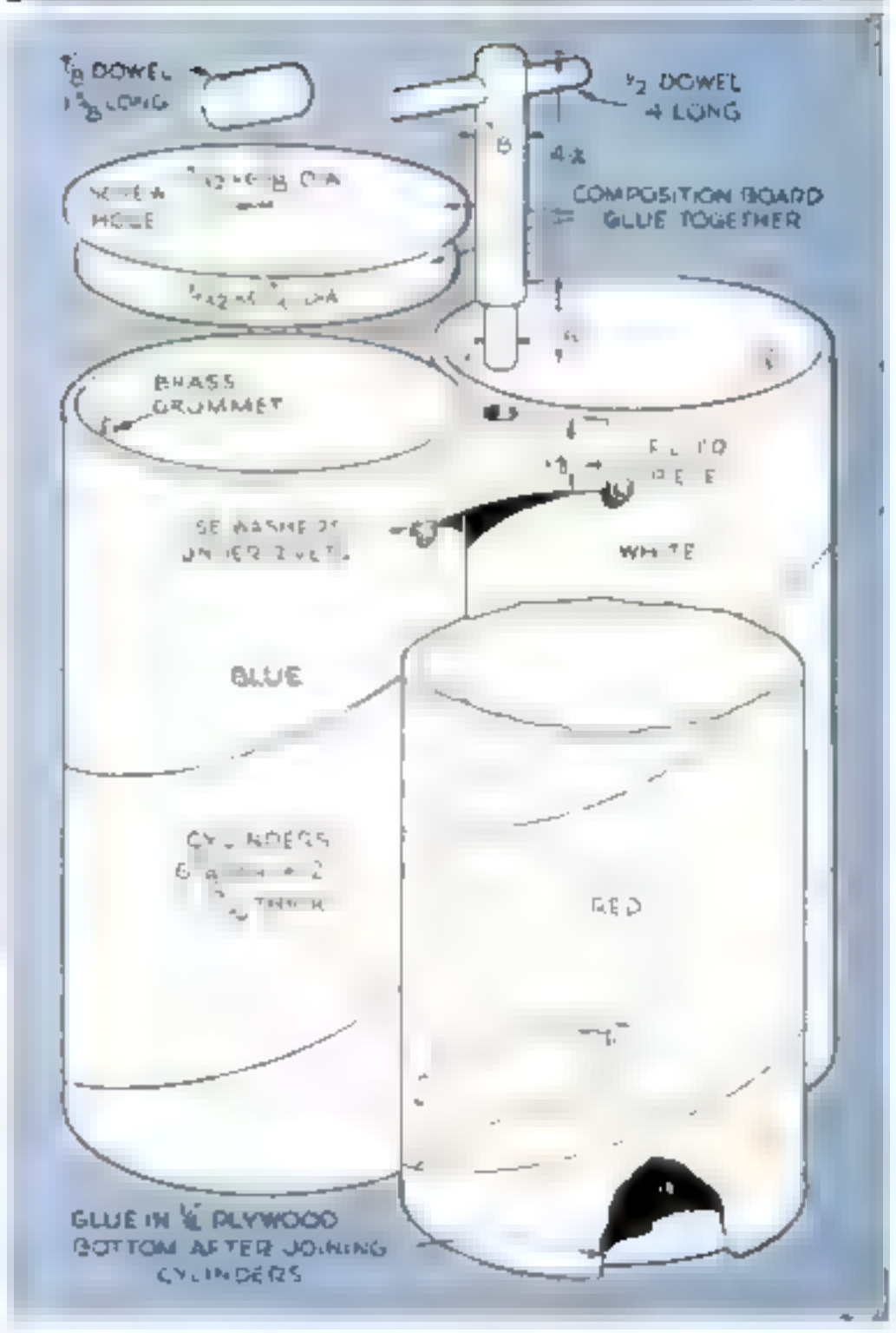
FOR SHUTTERS AND WINDOW BOXES

Shutters and window boxes enhance the appearance of many a home. The following color schemes for these accessories have proved attractive on some residences where they have been used.

BODY COLOR	SHUTTERS	WINDOW BOXES
White	Stained burnt umber	Deep blue relieved with white moldings
Silver gray with white trim	Dull red	Dull red
White	Light green	Pale gray trimmed with deep green
Ivory with warm drab trim	Warm drab	Warm drab trimmed with grayed green
Red brick with ivory trim	Ivory trimmed with warm drab	Ivory trimmed with warm drab
White	Fiesta yellow	Fiesta yellow
Canary yellow with white trim	Reddish brown	Reddish brown trimmed with pale green
Light lead color with white trim	White trimmed with Castilian blue	White trimmed with Castilian blue
Red brick with cream trim	Cream trimmed with creamy tan	Cream trimmed with creamy tan
Creamy gray trimmed with cream	Cardinal red	Reddish brown
White	Castilian blue	White trimmed with Castilian blue
Light lead color trimmed with ivory	Ivory trimmed with grayed green	Gray-green trimmed with ivory
Red brick trimmed with white	White trimmed with willow green	White trimmed with willow green
Warm drab trimmed with ivory	Castilian blue trimmed with black	Black trimmed with Castilian blue
Coral trimmed with ivory	Two tones of green	Two tones of green
White	Gray and Castilian blue	Castilian blue
Creamy gray trimmed with ivory-white	Same as trim but trimmed with fiesta yellow	Same as trim but trimmed with fiesta yellow: window sash, fiesta yellow

Triple Yarn Holder

FOR THOSE WHO KNIT IN GROUPS



Clubland Project

Average Time
5½ hours

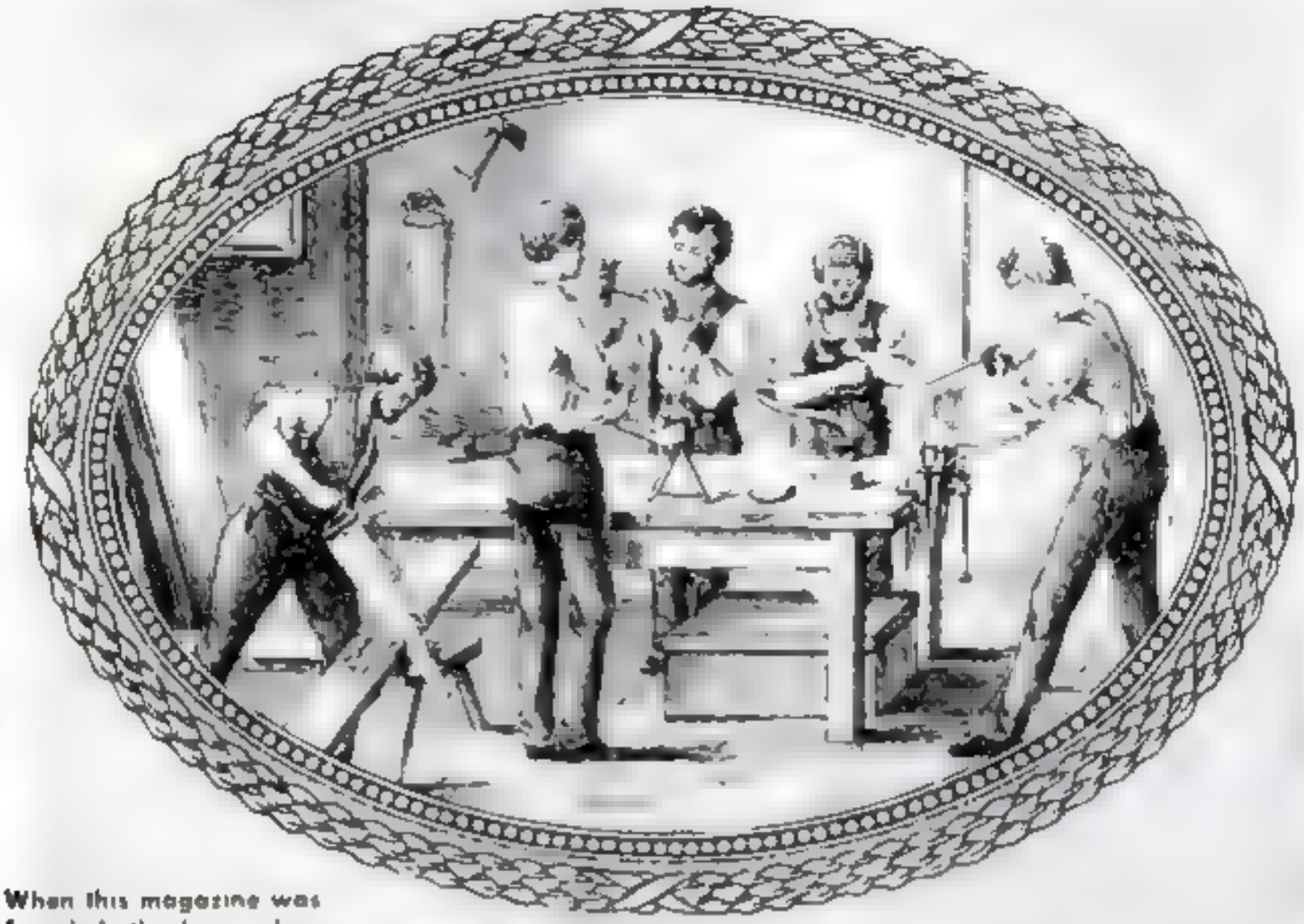
IT'S more fun to knit in company, as every woman knows. This colorful triple yarn holder is just the thing for the knitting clubs that are springing up everywhere. The compartments are big enough to accommodate partly finished work, needles and all, as well as yarn.

One 6' long cardboard tube, such as new linoleum is rolled up on, supplies the containers for two such units. This tube need not be precisely the diameter shown in the drawings, as the lids and bottoms can be made to fit. Cut three 12" lengths for each holder and fasten these together with hollow or other rivets at the top and bottom, using small washers as reinforcements on both sides of each rivet.

Lay out a pattern for the two filler pieces by drawing three tangent circles of the same size as the tube. Saw these parts from thick pine and drill a ½" hole in one for the handle shaft. Glue both in place.

Plywood or composition-board lids and bottoms are turned or sawed to size. The lids are most easily made by gluing together two parts to form a rabbeted edge. The upper should be exactly the diameter of the containers, but the inner should fit loosely to allow for painting. Short bits of dowel serve for the lid handles. The handle shaft is turned or built up from dowel and is drilled for a dowel crosspiece.

Apply two coats of shellac both inside and outside, then finish with enamel or flat paint. If the containers are painted different colors, use masking tape where they meet. When the paint is dry, set in eyelets for the yarn to pass through.—S. Y.



When this magazine was founded, the home shop presumably looked like this. From "The Practical Carpenter and Joiner," by Robert Riddell, copyright 1872 and published in Philadelphia

The Home

By HENRY H. SAYLOR

TO BRING the year 1872 into sharper focus from this distant standpoiot, let's recall a few historical tags. In that year the Suez Canal was opened. Only a few years before, the first cable was laid between England and America. "Alice's Adventures in Wonderland" was a fairly new book. A lad named Rudyard Kipling was just entering primary school. William Morris, Burne-Jones, and Rossetti were turning England's taste to better furnishings, more honest craftsmanship.

The decade had opened badly with the Franco-Prussian War. The ashes of our own Civil War were still heavy upon us. Grant was in his second term as President. Alexander Graham Bell was running "a school of vocal physiology" in Boston by day, and experimenting with tuning forks, batteries, and wires at night. In 1876 was granted his application for a patent on a telephone device.

It was not a day of leisure, of preoccupation with hobbies and pleasurable activites in spare hours. There were few spare hours for the men folk. Life was real; life was earnest.

E. Steiger, of New York, was publishing a monthly journal called *The Workshop*, but it was not aimed at the amateur craftsman. Filled with superb line engravings from French and classic sources, the journal was "Devoted to Art-Industry and the Progress and Elevation of Taste in Manufactures, Construction and Decoration — An Invaluable Work for Architects, Decorators and Designers Generally."

One may search in vain through advertisements of the day for tools and equipment specially designed to tempt the amateur. Among the ads in *Frank Leslie's Illustrated Newspaper*, *Harper's Bazar*, and *Harper's Weekly* one finds mention of fishing tackle, parlor magic, and ventriloquism. Here and there, among announcements of eight-percent first-mortgage railroad gold bonds, appears an ad for a knitting machine, or a home printing press, but no workbenches, tool chests, or books about what a man could

10TH ANNIVERSARY Feature

Workshop of 1872

make with his hands, just for the fun of it.

Harper's Bazar did on one occasion in the 1870's break down and give instructions for the making of a "folding Gothic screen." Window glass, gay chintzes, black ribbon for binding — all were brought into unity and a fancied semblance of art with the aid of gum arabic. Still another noteworthy suggestion for the home craftslady was a dog collar formed of interlocking brass rings, these latter being individually jacketed in crochet work. Designs for lambrequins (draperies to be hung from shelves or from casings above windows) and for Venetian embroidery were offered in great quantity and in unlimited art forms.

Apparently the ladies of that day were decidedly more prone to hobby riding than were the men. China painting, needlework, water colors and oils were among the activities chosen by those feeling a need for self-expression or for whiling away the idle hours. Characteristic of the time is the astonishing number of bypaths into which the ladies carried these perfectly reputable media. It was not enough to do water-color work on paper; they led their brushes over such surfaces as silk, satin, linen, and even plush. Oil colors, too, were made to flow over these same strange textures, and I have a faint though still sickening memory of one such masterpiece handed down as indisputable evidence of artistic genius among the family's gifts. "Puss Among the Wild Roses" was the title, I believe, and the struggle of paint globules in the jungle of a deep-pile black plush was one of those tragedies the mind can never quite shake off

Embossing leather with low-relief patterns from flower, animal, or geometric sources was another hobby of the day. And wood carving was then in one of its perennial periods of striving to emulate Grinling Gibbons. As a matter of fact, wood carving was being taught so efficiently in Cincinnati at the time that women's work sent from that city to the Women's Pavilion of the Centennial Exposition carried off a medal and diploma. Mantelpieces, overmantel decorations, bookcases, cabinets, screens — all these were embellished with the ladies' sharp tools, and blossomed forth in climbing vines, flowers, animal life, and arabesques.

There was certainly no lack of edged tools in great variety. Examination of contemporary catalogs prompts the thought that, except for electric propulsion, our tools of today are surprisingly like those of 1872, though the ratchet brace was something of a novelty. You could have bought a power lathe for wood or metal, band saw, circular saw, drill, and shaper. There was even a machine for sharpening saws. These tools would have had foot treadles or belt pulleys instead of electric motors, but they were capable of precise work.

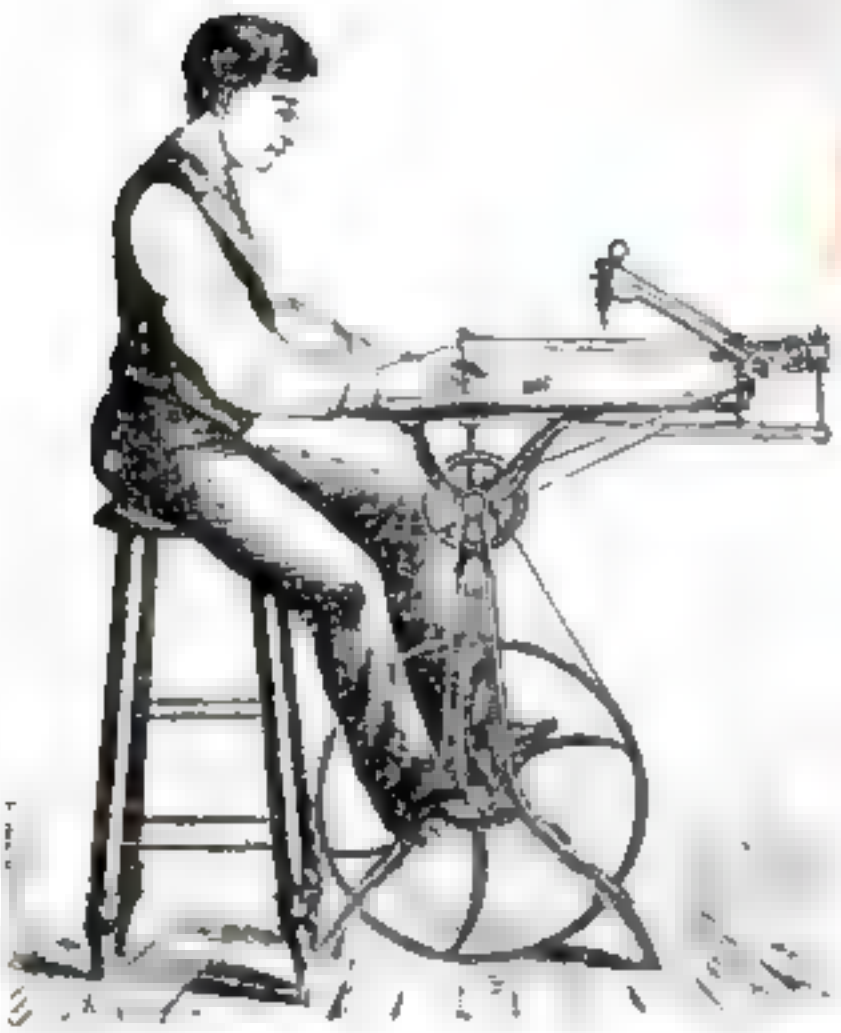
Apparently there was little or no thought that anyone might like to buy them for pleasure alone. They were turned out to equip the woodworking plant or the machine shop, and when the six-o'clock whistle blew, those who ran these machines went home to some relaxation other than working in wood or metal.

It is true that some of the tool catalogs occasionally ran a special offer of "Gentlemen's or Amateurs' drawing-knives" or of "carving tools for Youths and Ladies," but these were mostly second-grade stuff.

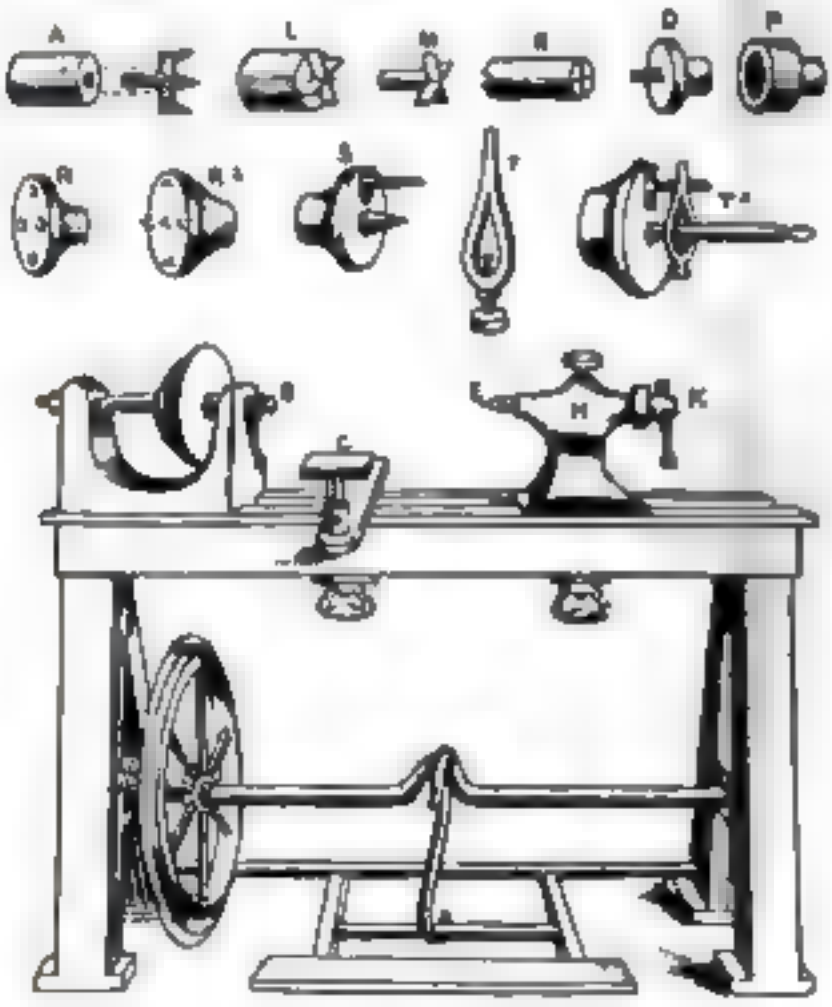
It is particularly interesting to find among the tool manufacturers of that day the names of several who are today familiar to all lovers of good tools — Henry Disston & Sons, the Stanley Rule and Level Company, Buck Brothers, and W. F. and John Barnes, the last-named firm founded in the same year as this magazine.

Fret sawing and wood carving were beginning to have an appeal to the boys of the household. George A. Sawyer wrote a series of articles on the subject for *St. Nicholas* in 1873 and followed it up with a book a few years later. In his foreword he argued: "For the young particularly, this is a most desirable pursuit. Its influences are alone for good, its associations solely refining and elevating. It does not take them to improper places, nor bring them in contact with doubtful characters."

In *Demarest's Young America*, C. A. Black



You rode your hobby much like a bicycle on this scroll saw, first manufactured in 1872 by the W. F. and John Barnes Company, of Rockford, Ill.



Foot-power lathe and attachments, from "The Young Mechanic," by James Lukin (1871). Nine editions of the book were sold in this country

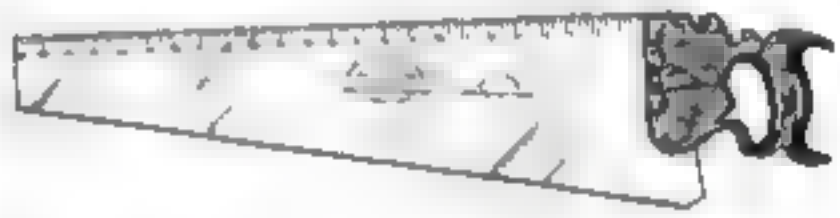
At right, an all-iron machinist's level, mason's plumb and level, and "graduating" plumb and level, from an 1870 catalog of the Stanley Rule and Level Co.

70TH ANNIVERSARY Feature

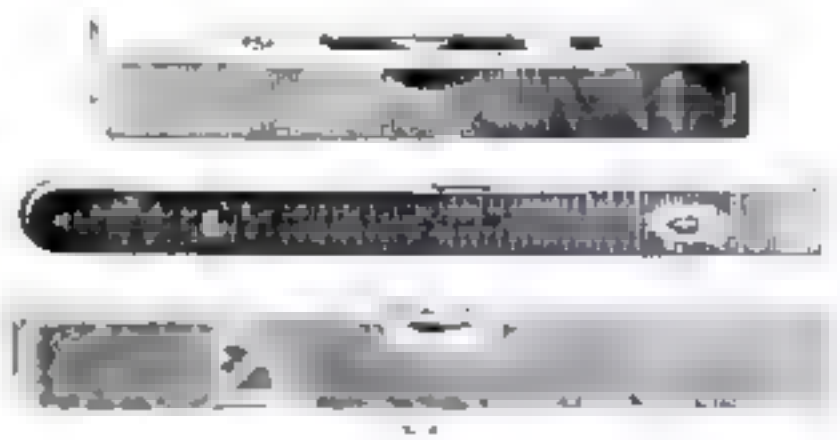
conducted a column called "The Farm and Workshop" in which he stirred the boys to simple handicraft creations, mostly toys of the jumping-jack type, with an occasional sled, stool, or bracket.

Among the premiums offered to boys by the *Youth's Companion* was a foot lathe with a set of turning tools. To get it the boy had to gather in 30 new subscribers.

Intricate detail and overelaborate decoration were the order of the day in all the crafts. Furniture was passing from the notorious Eastlake period to the Queen Anne. A bureau would have, possibly, a tall mirror above the marble slab covering the drawers, the mirror frame loaded with motifs from Greek, Gothic, Byzantine, and other sources. Tiny panels of burl walnut were framed by intricately curved and mitered moldings of considerable projection. The type was not one to invite the efforts of an amateur craftsman, even if leisure time had been plentiful. Moreover, there was a tendency to look down upon any such craft efforts. It was not quite the thing to do — this working like a laborer out of regular hours. Those who did it were suspected of being unable to earn their way as other men did, and of working overtime by reason of economic necessity.



This combination saw from the 1874 catalog of Henry Disston and Sons had, believe it or not, a 24" square, rule and straightedge, detachable handle, scratch awl, and plumb-and-level device



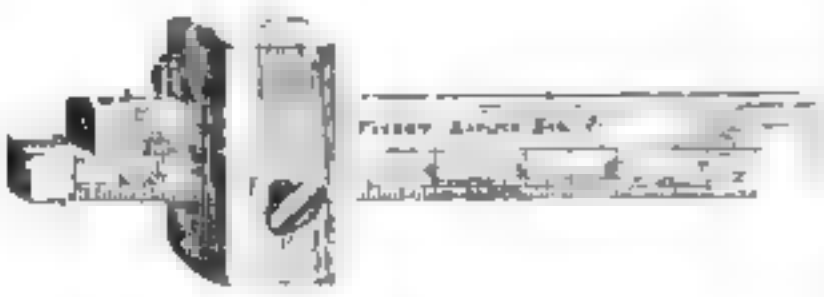
The few appearances in contemporary magazines of the how-to-make type of article usually dealt with weird products. Rope grille work was one. You were advised to buy sash cord, dip it in a glue size, wind it spirally around a stick or back and forth over pegs spaced on a board. After drying, the rope held its new shape and could be combined with other similar or contrasting forms in a wooden frame to form an overdoor grille. Painting or gilding the whole was advised as the final touch in the long-suffering cause of art.

Other and, to our minds, better media for self-expression were to follow before the turn of the century—beat ironwork and pyrography with particular virulence, and throughout these years the appeal of the fret saw was uppermost.

Manual-training books came in a flood after the century's end, and the interest in benchwork was carried from schools into the home. Then, along with the growing leisure, came the introduction of small motor-driven machine tools, which must be regarded as a chief contributing factor in establishing the modern home workshop. It is this type of home workshop that POPULAR SCIENCE has been consistently promoting in every issue for more than a quarter of a century.

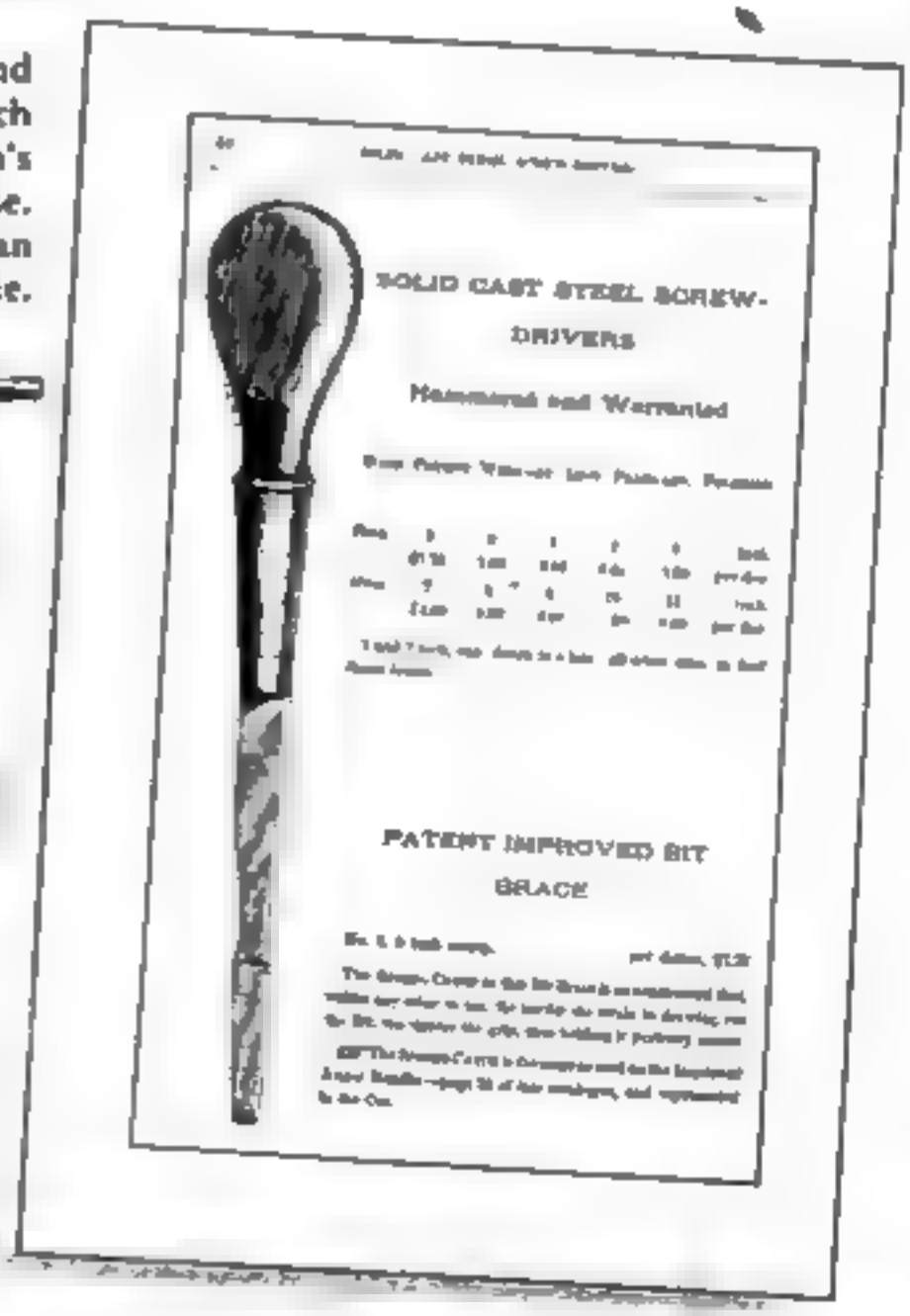
Today, the love of good craftsmanship and the native ingenuity developed from such humble beginnings are meeting the nation's need for the means of offense and defense. In the battle of production the American home workshop plays a new and vital role.

A wooden screw was used in this adjustable clamp. Iron straps secured the two blocks



Made of boxwood, this combination marking and mortise gauge had brass-faced bars and head, and brass thumbscrews. Its list price as given in an 1870 catalog of the Stanley Rule and Level Co. was $1.50. At the right is reproduced a full page from the same catalog. This is about two fifths actual size

Craftwork of 70 years ago was marked by painfully elaborate, intricate detail. This "waste-paper stand" typifies the carved work in popular favor then. Just to set it off to full advantage, the panels were backed with colored silk



SEVENTY YEARS OF PROGRESS IN PHYSICAL SCIENCE

(Continued from page 57)

gen, about one part is the heavy variety.

At the beginning of the twentieth century, physicists were puzzled by certain observations on the emission of light and heat from heated solids. Earlier attempts to explain these observations on the basis of existing theories had failed. Max Planck, in 1901, made the startling suggestion that these observations could be explained by assuming that energy is emitted or absorbed by a body, not continuously, but in the form of bundles of energy or quanta. This is the quantum theory, which, as has been demonstrated subsequently, fits in with all observations on interaction between matter and energy.

This theory thus represents in a sense a return to Newton's older theory that light is propagated through space in the form of "darts" or light corpuscles. Later studies led to the replacement of Newton's theory by the wave theory of Huyghens, and Clerk-Maxwell's work seemed to confirm this. However, after Planck enunciated his theory, other observations accumulated rapidly and apparently could be explained only in terms of a corpuscular light theory, that is, in terms of quanta.

One such set of observations is that relating to the photoelectric effect. When light shines on the surface of a metal, electrons are emitted. Nowadays this observation finds a multitude of uses in the "electric eye," the photoelectric cell used to measure photographic exposures, to open doors automatically, to make the television camera see, and the sound movie talk. Usually the photo cell consists of a glass bulb in which there is a plate coated with cesium, or with some other alkali metal. When light falls on this plate, electrons (photoelectrons, as they are called) are emitted, and they carry a current across the space to another electrode. Such a cell acts as a light-controlled switch, to regulate the flow of electricity.

A peculiar thing, found in early studies of the photoelectric effect, was that for any substance capable of emitting the photoelectrons, there is a certain minimum frequency needed for the light falling on it before any electrons can be ejected. If the light has a lower frequency the surface remains inactive no matter how bright the source.

On the basis of the quantum theory, this was explained by Albert Einstein in his law of the photoelectric effect, for which he would rank among the great even if he had never thought of relativity. Einstein's law states that, in the absorption of light by an electron, the energy of the emitted electron depends only upon the frequency of this light and not upon its intensity. Since the energy quantum is proportional to the frequency, this means that an electron has to absorb a quantum (or photon, as it is known) of a definite magnitude before it can leave the surface.

Not only can a photon set off an electron, an electron can also start a photon on its journey. Experimenting in 1895 with Crookes tubes in his laboratory at Wurzburg, Wilhelm Konrad Roentgen found a curious effect. From one of the tubes which was covered with black paper there emerged some invisible rays which had the property of making certain materials glow, or fluoresce. He called them X rays, because he did not know what they were, and X stood for the unknown. Immediately they proved of tremendous utility, especially for examining the inside of the body.

Whatever they were, they appeared when electrons were suddenly stopped against a target. In the early X-ray tubes, the electrons were torn from the metal of the cathode by bombardment of positively charged residues of atoms. Such tubes were very erratic in behavior. Though small, the exact amount of gas that remained in them was critically important. However, in 1913, in the General Electric Research Laboratory, a new type of tube made its appearance. It was highly evacuated, and the electrons were obtained, in accordance with the observations of Richardson and Langmuir, from an incandescent filament. Most modern tubes are of this type, including the million-volt tube used to take pictures through several inches of steel in a few minutes.

Though one theory of the X rays was that they were extremely short waves, like light, the first demonstration of the truth of this came in 1912 when Max von Laue, in Berlin, succeeded in diffracting them by a crystal. A piece of glass, ruled with parallel lines, perhaps 10,000 to the inch, will act in a manner similar to a prism, breaking a beam of white light into a spectrum. While the prism refracts the light, the grating diffracts it. X rays are composed of waves too short to be diffracted under usual conditions by such a grating, but Von Laue suggested that the parallel planes of atoms in a crystal might act as a fine natural grating.

This was quickly confirmed by sending a beam of X rays through a crystal to a photographic plate. Not one spot, but a number was obtained, the positions varying with the orientation of the crystal. Next, in the

TELEVISION finds application in many fields besides that of pure entertainment. One of its possibilities as an aid to education is shown in the photograph at right, in which a sculptor is modeling a head in front of the television camera. It is suggested that art lessons might be telecast to students in this way

hands of Sir William Bragg and his son, Dr. W. L. Bragg, in England, such methods were used to reveal the way the constituent atoms were arranged in crystals of solids. Now a most important application of X rays is the X-ray spectrograph, used for such studies in a host of laboratories.

When electrons are accelerated in an X-ray tube by the high voltage applied to the terminals of the tube, the wave lengths of the X rays obtained are found to have a limiting frequency which is higher the higher the voltage used. This is again in accordance with Einstein's law, mentioned previously, and is interpreted thus: When an electron of given energy hits the target (or anode), a quantum of X-ray energy is emitted as a photon of definite frequency.

This view of radiation (whether visible or X-ray) as constituted of photons or light corpuscles, offers a very simple explanation of an observation made by Arthur H. Compton in 1923. When X rays strike any surface, secondary rays are emitted. Contrary to the observations on the scattering of ordinary light, some of the secondary X rays possess a lower frequency than that of the original incident X rays, that is, they correspond to photons of lower energy.

The interpretation of the Compton effect is similar to that used for the result of a collision between two billard balls. In the present case, one of the balls is the photon or light corpuscle and the other is an electron. The photon bounces away from the electron with loss of momentum and energy. This energy loss is indicated by the decrease in frequency of the X radiation, and the recoiling electron acquires a corresponding increase in both energy and momentum.

An analogous explanation applies to the discovery of the Indian physicist, Sir Chandrasekhara Venkata Raman, that ordinary or visible light suffers a change in wave length when it is scattered by a very pure liquid. In this case there is an interchange of energy between the photon and the vibrational energy of atoms in the scattering molecules.

By far the most important application of the theory of energy quanta was made by Niels Bohr in 1913. This led to an interpretation of the origin of atomic spectra.

As will be mentioned below, Sir Ernest Rutherford was led by his investigations in the field of radioactivity to suggest, in 1911, a nuclear theory of atomic structure. According to this theory, an atom of any element consists of (1) a positively charged nucleus of infinitesimally small dimensions located at the center of the atom and (2) one or more electrons external to this nucleus, the number of these being equal to the number of units of positive charge on the nucleus.

The magnitude of this charge is known as the atomic number, and it varies from one, for hydrogen, two for helium, and so forth, to 92 for uranium, the heaviest atom known. Since the mass of the electron is only about 1/2,000 that of a hydrogen atom it follows that practically all the mass of the atom is concentrated in the nucleus, in spite of the fact that the diameter of the latter is about 100,000 times less than that of the atom as a whole. Furthermore, the radioactive disin-

tegration phenomena again have their origin in the nucleus, while the ordinary chemical properties of atoms, the emission of light and X rays, and other physical phenomena, are due to changes in number and arrangement of the extra-nuclear electrons.

This view, that the chemical and practically all the physical properties of the elements are governed by the magnitude of the atomic number, received its first and most striking confirmation in 1913 through the work of a young English physicist. This was H. G. J. Moseley who, unfortunately, was killed at Gallipoli. Investigating the characteristic X-ray spectra of a number of elements, he observed that these spectra showed a progression in wave length which was parallel with the change in atomic number. In fact he was able, from his observations, to deduce the atomic numbers for a series of elements from a knowledge of the atomic number of one of them.

In 1913, Bohr, a Danish physicist working at Cambridge, England, in Rutherford's laboratory, proposed the following theory to explain the emission of light by atoms and molecules, when excited either in an electric discharge (as in the neon tube and sodium vapor or mercury vapor lamps) or at very high temperatures, such as exist in the sun and other stars.

This may be illustrated most simply by referring to the hydrogen atom, which consists of a nucleus of unit positive charge and a single electron. Under normal conditions, the electron revolves in a circular or elliptical orbit around the nucleus, under the influence of the electrical attraction of the latter. In one electric discharge, electrons emitted from the cathode will be suffering constant collisions with atoms, and if these electrons have sufficient energy—and only then—the electron in the hydrogen atom will be excited to revolve in some one of a series or orbits farther out from the nucleus. The farther out the orbit, the greater the amount of energy which the electron in the orbit must acquire in order to get out to it. The Bohr theory shows that there are very good reasons for assuming a finite number of possible orbits. When the electron once gets out to one of these orbits, it tends spontaneously to return to the original orbit nearer the nucleus. This corresponds to a decrease in energy of the atomic system and this decrease appears in the form of a photon of definite frequency, just as was observed in X-ray emission.

In the case of atoms of higher atomic number, the electronic orbits are more numerous and more complicated, but in all cases the process of light production consists of two stages: (1) the absorption of energy by the atoms from the electrons in the discharge, and (2) the re-emission of the energy in the form of photons, each possessing a definite frequency.

In this manner, Bohr was able to account in a very satisfactory manner for a large number of observed regularities in the line spectra of the elements, and in the case of hydrogen and ionized helium, it was possible, from a knowledge of the nuclear charge and the charge and mass of the electron, to calculate the frequencies of the lines in the different spectral series.

A curious feature of the work in physics during the past 20 years has been that after the quantum theory had become popular, with its picture of light as separate units rather than waves, the electron, which had been thought of as a particle, was just as clearly demonstrated to have wave properties. The work of C. J. Davisson and L. M. Germer, in the Bell Telephone Laboratories, followed by that of G. P. Thomson in Cambridge, showed that when a beam of electrons was either scattered by or reflected from certain materials, the electrons came off in certain perferred directions. This could be explained only on a wave basis such as that suggested by Louis de Broglie. Now this principle is being used as a new means of studying the structure of matter.

Still further modification of the ideas of the electron came from the work of W. Heisenberg and his "indeterminacy" principle. This states that one can never accurately determine both the position and velocity of an electron simultaneously, because whatever is done to increase accuracy in the determination of position decreases accuracy in determination of velocity, and vice versa. As a result, the modern idea of the atom does not retain the definite orbits of Bohr. Rather are the orbits somewhat hazy regions, in which there is a high degree of probability for the occurrence of the electron.

Led by the new knowledge of X rays to study the radiations from natural substances, Henri Becquerel, of France, found in 1896 that compounds of uranium gave off similar rays. They, too, had the property of passing through black paper and other materials opaque to light. Two years later Pierre and Marie Curie isolated from pitchblende the element that was responsible, namely radium.

It was then found, largely as a result of the work of Rutherford, that radium and similar elements were constantly undergoing transmutation from one atomic type to another. Not only are gamma rays, similar to X rays, given off in the process, but also apha rays, which were shown to be helium atoms which had acquired two units of positive electricity, and beta rays, which were identified as high-speed electrons. This was

the first evidence that some, at least, of the elements are capable of transforming spontaneously into other elements, and that a change, such as the ancient alchemists had vainly sought, could actually occur. Then Rutherford and Soddy found that in all such cases, whether starting from uranium, thorium, or actinium, the final product of these radioactive series of elements is an isotope of lead.

Thus the idea of an indivisible particle (the idea from which the name "atom" was derived) had to be discarded. It was as a result of his series of observations on the scattering of alpha particles by hydrogen and helium that Rutherford was led to his theory of the nuclear atom. But since these changes went on their way indifferent to the intervention of man, efforts were then made to achieve atomic disintegration artificially.

In 1919, Rutherford succeeded, thus realizing the dream of the alchemists, though, to be sure, in a form very different from their ideas, since it did not yield gold, either actually or figuratively. He fired alpha particles at nitrogen, and some new particles were formed, which were nuclei or hydrogen atoms. We now call them protons. This was a change in the actual nucleus of the atom, not just in the outer electrons, and this observation thus opened a broad new field.

Cockroft and Walton, at Cambridge University, then used high voltages to speed up protons themselves to disintegrate the nuclei of still other atoms. The problem next was the production of high voltages. Robert J. Van de Graaff, at the Massachusetts Institute of Technology, invented a type of electrostatic generator which has been duplicated in several laboratories, often in steel tanks with gas at high pressure. Up to about 5,000,000 volts can be obtained with this machine.

Still higher voltages, though not as precisely calibrated, can be obtained with the cyclotron, invented by Prof. Ernest O. Lawrence, of the University of California. This is an "atomic sling-shot." In the field of a huge electromagnet, positively charged particles are swung around and around, speeded on each trip by electrical forces. A new cyclotron, designed to speed particles with the equivalent of 100,000,000 volts is now nearing completion under Dr. Lawrence's direction at Berkeley

Very recently, a comparable device for speeding negative particles—electrons—has been developed by Dr. Donald W. Kerst, of the University of Illinois. This is the electron accelerator, and one for 100,000,000 volts is under construction in the General Electric laboratory.

A new particle made its bow in 1932 as the result of experiments at Cambridge University by James Chadwick. Alpha particles from radium were shot at beryllium, for example. The beryllium was changed to carbon, but also, in the process, this new particle appeared from the nucleus. Though it has approximately the same mass as the proton, the previously known unit of the nucleus, it has no charge, and it was called the neutron.

In 1934 Mme. Curie's daughter, Irene, and her husband, Frederic Joliot, found that aluminum bombarded with alpha particles became radioactive, giving off other radiations and transforming into atoms of other elements. A few months later Enrico Fermi, who is now at Columbia University, found in Italy that neutrons had the same effect, especially if they were slowed, as by passing through paraffin. The trouble with fast neutrons is that they go through the at-

TWO LEADERS IN MODERN RESEARCH. Dr. Coolidge, the author of this article, looks on in amusement as Charles F. Kettering ("Boss Ket") tries to pull a bar from a powerful new Alnico magnet assembly

om so quickly they have little chance to act. The slow neutrons take longer, and the nucleus of the atom has more opportunity to capture one.

Using this principle, cyclotrons of the nation are kept busy making radioactive isotopes of many elements. For numerous purposes, medical and industrial, these can take the place of natural radium. All of the elements have been found to have radioactive forms, but, for some, the life is so short that they have little practical value.

The year 1939 will be remembered in the history of physics because that marked the discovery of another kind of reaction of the nucleus—one that may in the future have tremendous practical importance. Certain very heavy elements can be split by neutrons into two parts, which separate with the release of an enormous amount of energy. In the case of uranium, slow neutrons with relatively little energy can induce this fission, as the process is called. Further, when uranium divides, more neutrons are emitted, and these, perhaps, may then be used to induce fission in more uranium nuclei.

If this can be made a self-sustaining reaction and be provided with adequate controls, we may have a means of getting power from atoms. It has been calculated that in this way the fission of a pound of uranium could be made to give as much energy as the combustion of 2,000,000 pounds of coal. However, the trouble is that ordinary uranium will not work. This consists mostly of an isotope of mass number 238, and about 0 7 per cent of one with mass 235. The latter is the one that shows the effect. It has been isolated with the mass spectrograph, in amounts infinitesimally small, in our General Electric laboratory and also at the University of Minnesota.

The year 1932, which was distinguished by the birth of the neutron, was also the year in which the positive electron—the positron—was discovered. It, too, has been found to play an important role in nuclear reactions. It was discovered, however, in radiations coming to the earth from outer space—so-called cosmic rays. Back in 1911 it had been found that some radiation was striking the earth with the power of making electrically charged material give up its charge. These rays have been studied extensively in this country by Arthur H. Compton and R. A. Millikan, as well as by many other workers here and abroad. The primary rays which come from space never reach the ground, and their exact nature is still a problem. The secondary rays, which they produce, include many particles called mesotrons, with about 200 times the mass of the electron.

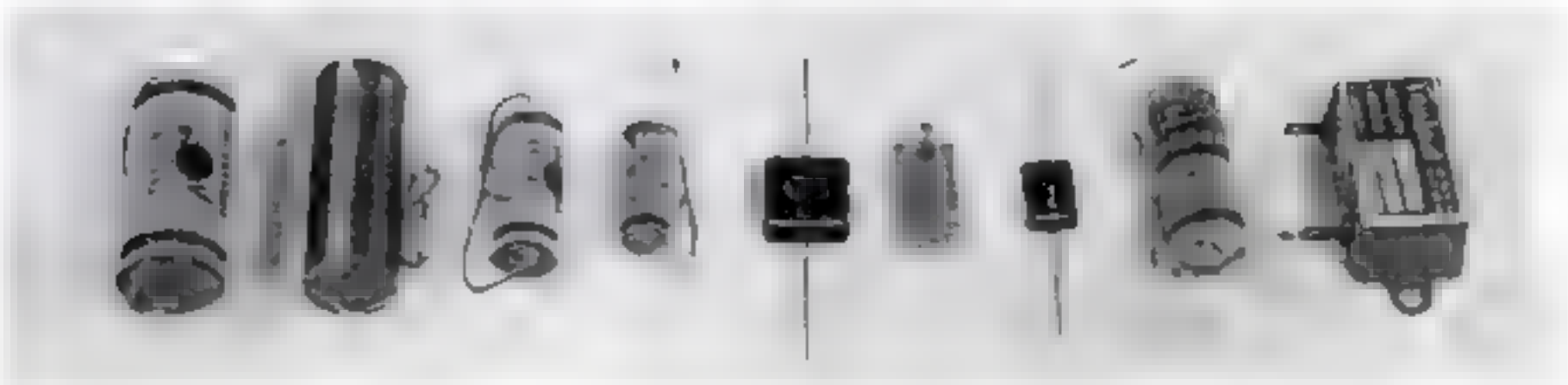
These, and other cosmic ray particles, can be made visible by the trail of fog they leave behind when they penetrate very moist air in a "cloud chamber." If the chamber is in a strong magnetic field, the paths are curved, and the amount of curvature tells their energy. This corresponds, in certain cases, to hundreds of millions or even billions of volts, which indicates energies larger than any previously known. It was with such a cloud chamber that Carl D. Anderson, at the California Institute of Technology, found the positron in cosmic radiation. Because a trail curved to the left instead of to the right, it showed that the responsible particle had a positive charge. Sometimes two tracks appear together, when a positron and electron pair are produced from a quantum of energy in the cosmic rays. This appears to be the actual conversion of energy into matter!

Such a conversion was not as startling as it might have been at the beginning of our 70-year period, for the theory of relativity of Einstein had shown that matter and energy are equivalent. Indeed, the energy of the sun and other stars is now believed to come from the actual conversion of some of the star's material into energy.

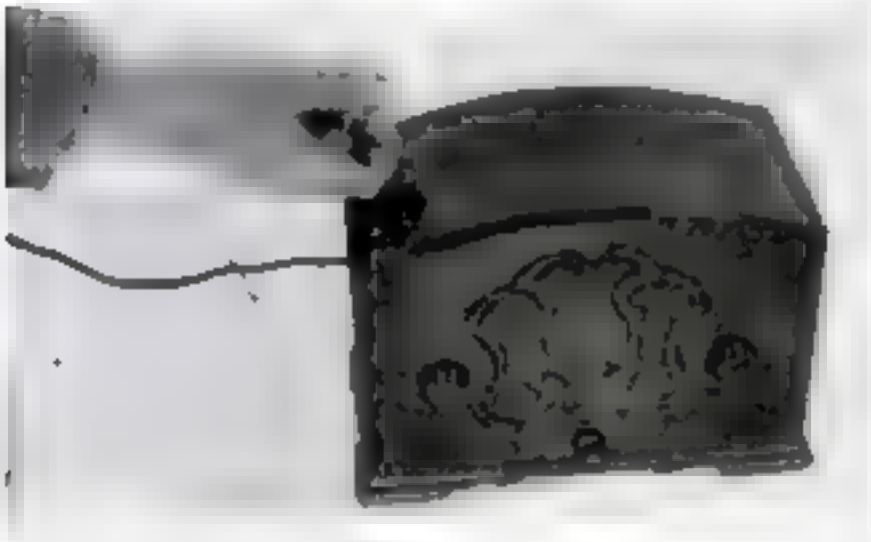
Seventy years ago, when light was supposed to consist of waves in the hypothetical ether, it seemed as if there ought to be a means of detecting the earth's motion through this ether. In 1887, the two American physicists, A. A. Michelson and E. W. Morley, performed an experiment to test this. Essentially they measured the time it took the two components of a divided beam of light to travel back and forth over equal distances, one going with the earth's supposed direction of motion, the other at right angles to it. The latter, it was thought, should take longer, but they found no difference.

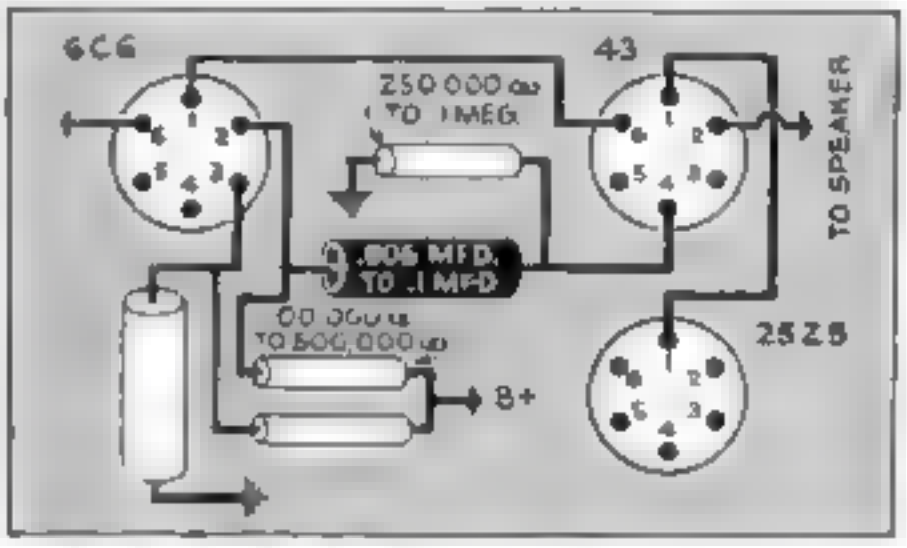
The full story of the way this developed into Einstein's special theory of relativity of 1905 and his general theory, announced ten years later, is too long to relate here, but it has been one of the most important of all the great advances during our 70-year period, or indeed in the history of physical science. For instance, the concept of the equivalence of matter and energy tells us that only a kilogram of matter—any kind of matter—if converted into energy would yield 25,000,000,000 kilowatt-hours, more than a year's supply for New York City.

Servicing Your Radio—PART 2

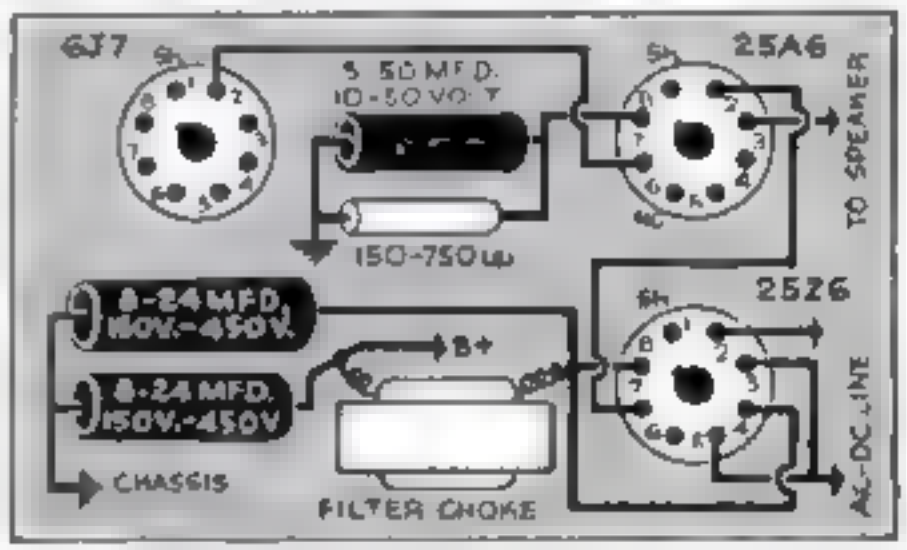


FIXED CONDENSERS. Nine types commonly used, left to right: .5-mfd. paper condenser, 8-mfd. midget electrolytic condenser; two (.05 and .02-mfd.) small paper condensers; three mica condensers (.002, .00075 and .0001-mfd.); a 50-volt, 25-mfd. electrolytic condenser; and a 1-mfd. paper condenser in a steel shell

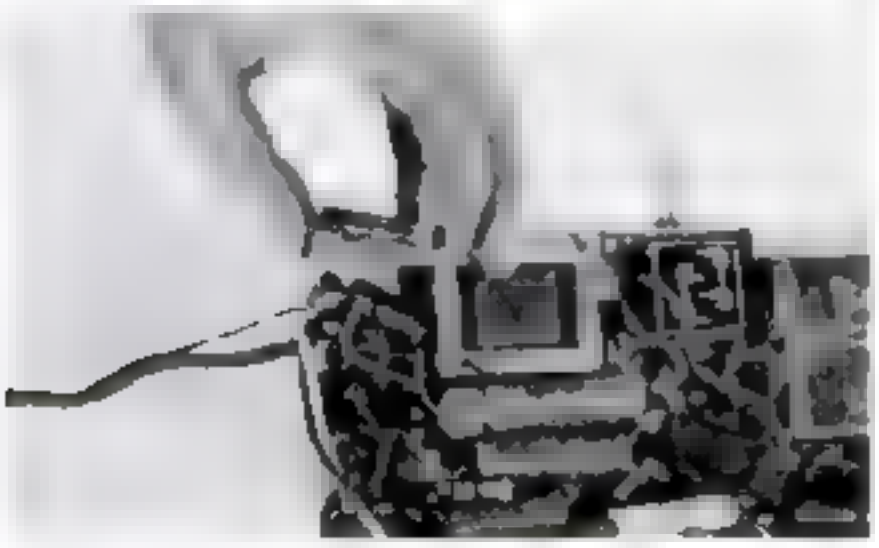


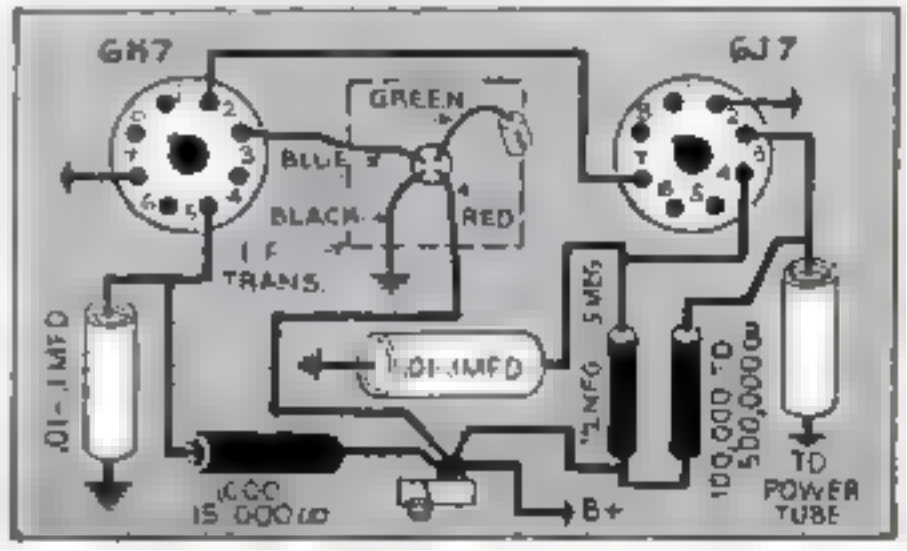


IF RECEPTION STOPS suddenly and resumes when the cabinet is knocked, the cause may be a loose connection or a bum tube. Or it may be a bad audio coupling condenser. This looks like the .05 or .02 paper tubular shown above. Diagram shows location. Before replacing, connect an .05 across it for a test

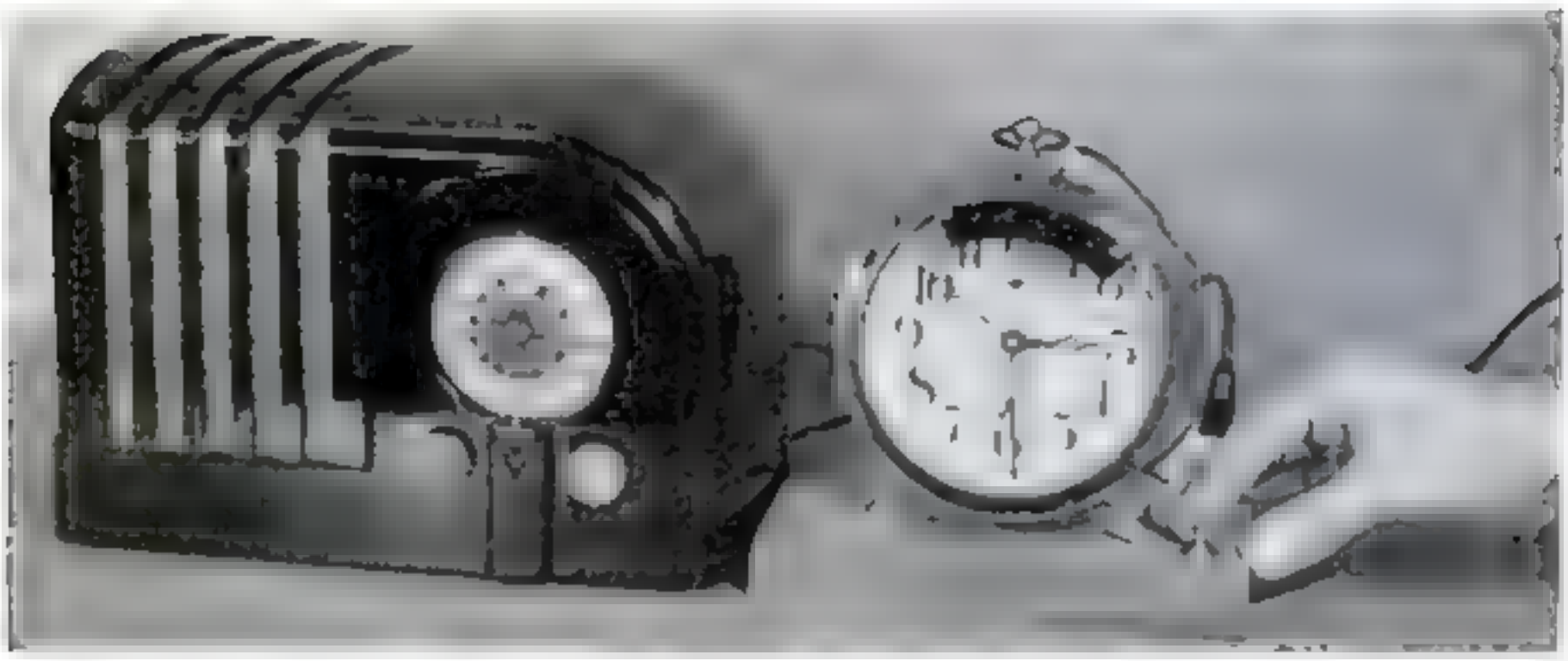


HUMMING is usually due to a faulty electrolytic condenser like the 50-volt, 25-mfd. shown above, across the power-tube bias resistor, or one like the 8-mfd., in the filter circuit. Connect an 8-mfd., 450-volt condenser across each electrolytic condenser in the set until the faulty one is found, and replace it





FADE-OUT experienced on many old sets is due to a fixed carbon resistor that has become crystallized. It usually can be recognized by a coating on its surface. If not, try connecting a 50,000-ohm, 2-watt resistor across each carbon resistor in the 8+ circuit. If playing resumes, replace with one of correct value

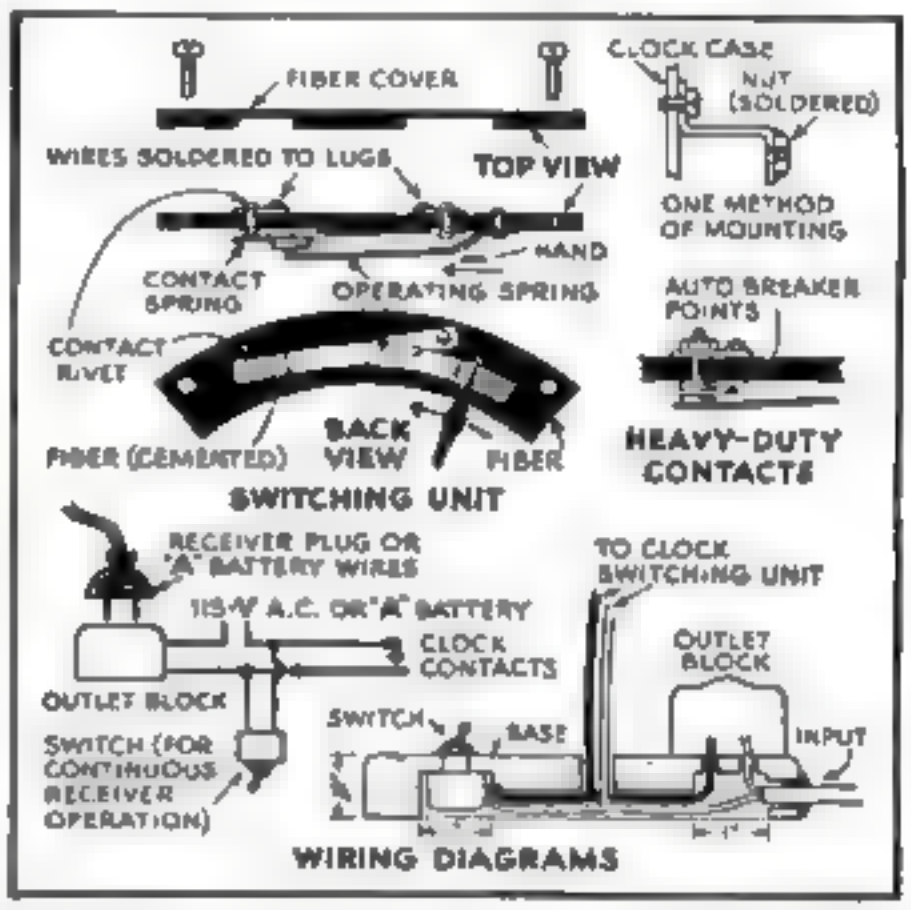


With the switch on, regular war bulletins are tuned in automatically; off, the radio operates as usual

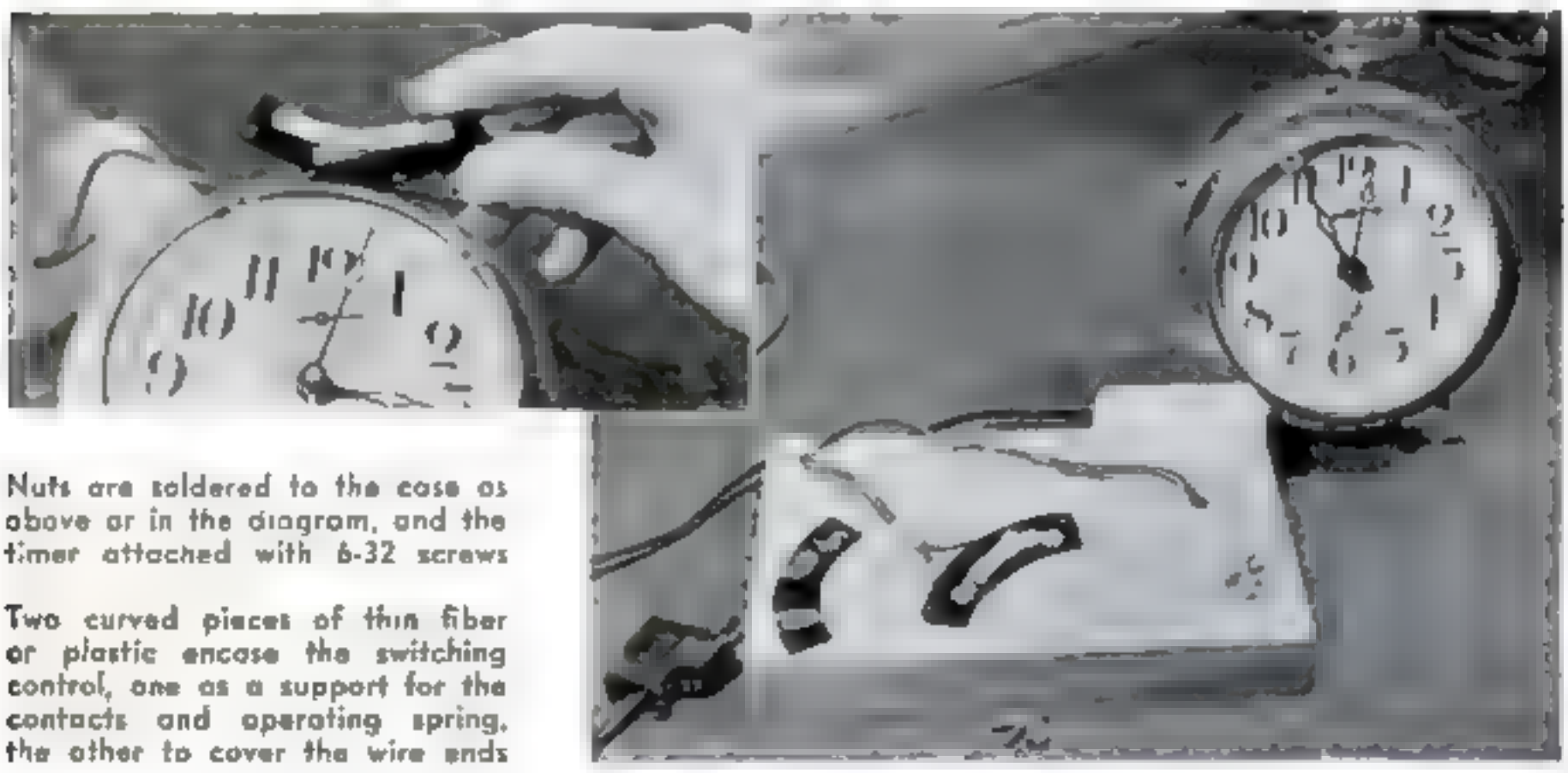
WAR-NEWS TIMER

FOR YOUR RADIO

YOUR radio can be turned on automatically hourly to catch regular war bulletins with this timer built around a clock, preferably an electric one for accuracy. Two strips of springy brass or bronze, attached to the face as shown, provide a circuit that closes when the minute hand makes contact and breaks to shut off the receiver when the hand has passed. The arched strip can be adjusted for contact to be made about 30 seconds before the hour and to end six minutes later, covering fully the time of most hourly news broadcasts. A second switching unit can be made to catch the half-hour bulletin periods. The only alterations of the clock required are removal of the glass and soldering of nuts to the face rim.



Wiring diagram and parts used in the timer. The heavy-duty contacts are best for large receivers



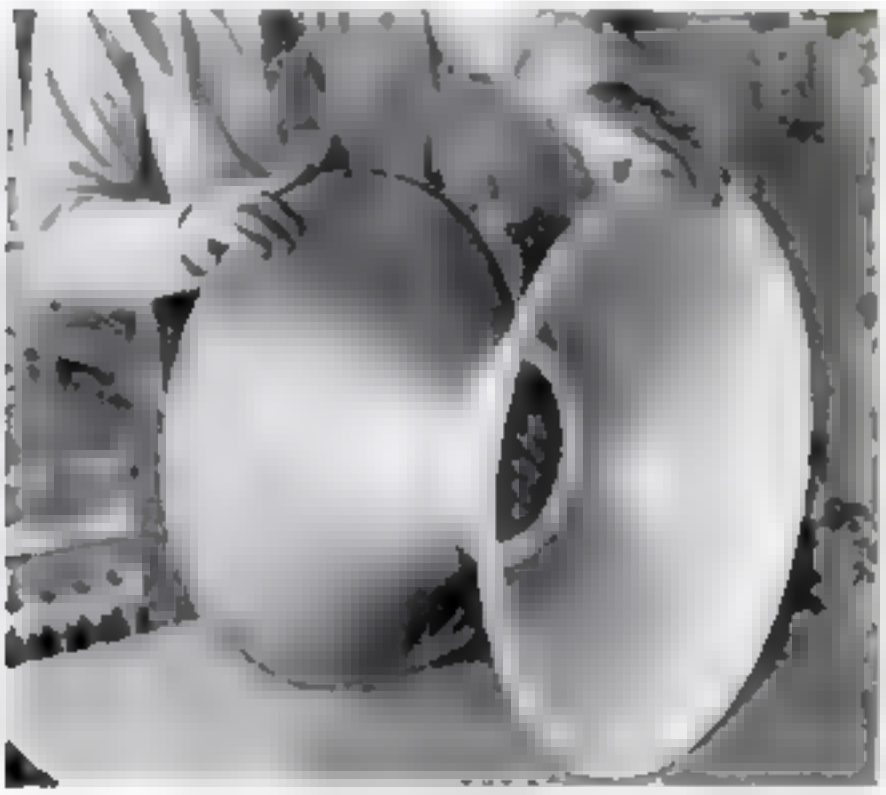
Nuts are soldered to the case as above or in the diagram, and the timer attached with 6-32 screws

Two curved pieces of thin fiber or plastic encase the switching control, one as a support for the contacts and operating spring, the other to cover the wire ends

Radio Ideas

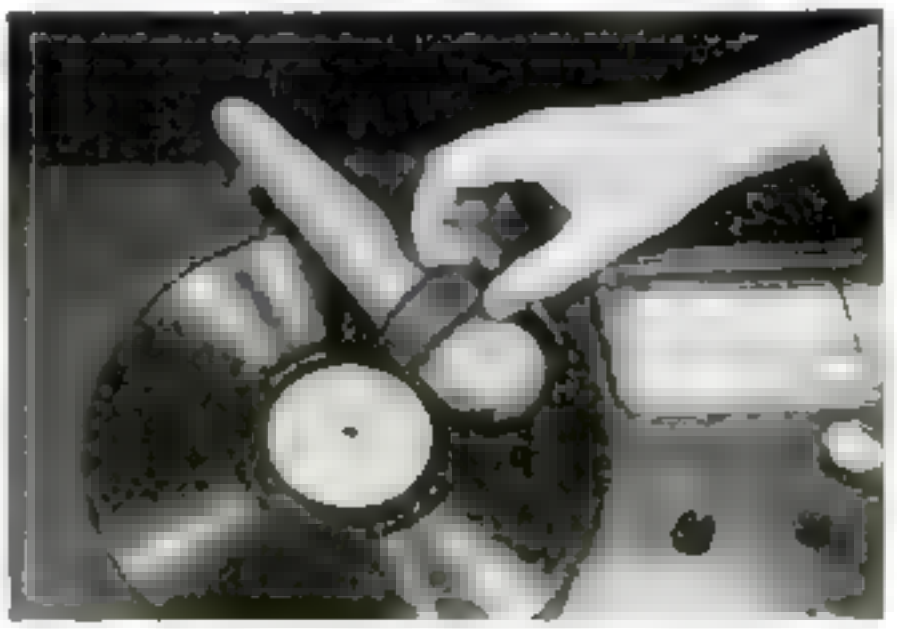
AN FM ADAPTER disguised as a set of books has been put on the market for those who object to the appearance of conventional adapter cabinets. Complete with bookends, the unit conceals its real purpose when, for example, it is placed on top of a console-type radio, to which it is connected by a cable at the rear. The backs of the books comprise the doors which swing open to reveal a tuning dial and six automatic push-button tuning keys. The cabinet houses a nine-tube receiver. This is one of the first adapters giving push-button control on the FM band

With doors open, tuning controls for a nine-tube FM converter are exposed. The rest of the time it looks like a set of books on your radio



A NEW TWO-WAY SPEAKER BAFFLE that projects sound in opposite directions, thus serving the purpose of two normal directional speakers, is especially designed for paging and intercommunication systems in factories, Army barracks, airports, and other locations requiring extensive sound coverage, such as beaches, playing fields, and the like. The flared bells are made of pressed steel finished with aluminum lacquer. A single, standard eight-inch speaker-cone unit may be easily installed between the twin bells. The outside diameter of the device is 21⅛ inches, while its total width is 14 inches. Convenient suspension loops are provided for hanging from the ceiling or other support, and the required fittings are supplied for attaching its speaker

RECORDING OR REPRODUCING of phonograph records is possible with a single pick-up arm of new design. Extremely light in weight, the combination pick-up has a sliding weight on its arm with which the desired pressure on the needle point may be obtained. Thus, for record playing, the weight is slid away from the magnetic pick-up unit of the arm. For recording on grooved record blanks, the weight is moved in the opposite direction, increasing the pressure on the cutting needle. The unit is available with either high or low impedance, while its frequency range is from 60 to 5,500 cycles.



Sequence Shots

These pictures hardly need labeling as a movie. A glance tells you there is a story here . . . . . Above, we have grandmother preparing to bake, and below, left and right, Edith joining in the fun

HOW TO TELL A MOVIE STORY WITH A SERIES OF STILL PHOTOGRAPHS

By Franklin Judson

Instructor in Cinematography
Art Center School, Los Angeles, Calif

"ONE picture is worth a thousand words." So goes the familiar Chinese proverb. I prefer a modern version: One picture is a record, but two or more tell a story. And one good story, related in a well-planned sequence, offers far greater interest and significance than fifty itinerant, random snapshots.

You see all about you evidence of the validity of this concept. Both the movies and the magazines utilize sequence to develop their stories. Long shot, medium shot, close-up. The same principle applies to the presentation of both movies and stills. Study this issue of POPULAR SCIENCE MONTHLY, and you will note many examples which bear me out.

Long shots serve to present the situation and introduce the characters. These are called establishing shots. Medium shots give you a fairly intimate view of the people and immediate surroundings. Close-ups bring both people and things into individual prominence, and give you the feeling of a personal introduction.

The practice need not be limited to professional photographers. In every home there are a multitude of stories crying to be filmed. You need only a camera, three flood lamps (or a flash if you want to stop action), two understanding and sympathetic relatives or friends who are willing to act, and enough patience to sketch your shooting program in advance.

Start with a script, and don't make it a one-man job. After dinner some evening, get the family together and explain the story just as a movie director outlines a scenario to his cast. Ask for ideas, and soon you'll have a basketful of suggestions. Now go over the ideas, starting with the number one establishing shot, and jot them down as they come. Don't worry about order yet. You're after ideas.

This procedure was followed in photographing the series shown on these pages. I presented the idea to my class in cinematography, and in half an hour, with suggestions popping from 20 people, we had our shooting list. Once completed, it was a simple matter to rearrange it in logical sequence, commencing with Mrs. Ernest Elsner, the grandmother, preparing to bake a cake, and reaching a climax with little Edith Warrack enjoying the results of her own cooking. Every step photographed leads logically to the concluding shot.

I cannot emphasize too strongly the importance of preparing a script. It not only stimulates thinking; it also enables you to make your mistakes on paper. Further, when putting down your thoughts in black and white, you are beginning to create pictures, not merely recognizing the good ones after they come out of the developer. The script need not be elaborate—just a list of situations indicating briefly action and position with relation to the props and background.

The next step is to convert each situation into a match-stick drawing. By this means you will visualize easily how your final pictures will look. If you are shy about show-

Now the two sift their flour, with the focus on the little girl, the main point of interest

"Just a minute, I'll help." A close-up of grandmother's hands helping Edith scrape the shortening off the spoon

ing the sketches to your associates, don't. Crude drawings will serve your purpose as well as finished ones, for they are merely a guide, although creating them may bring up new ideas.

With the sketches complete, return to your script and break it down into camera setups. If the action calls for several pictures of two people at a workbench, shoot all of them before rearranging the lighting and moving across the room to get them at some other job. You can refer to the sketch applying to each picture before making an exposure, and in that way know whether the scene fits the continuity.

As clearly as possible, each picture should show its own motivation for the next. In our introductory shot, we have established the grandmother setting out ingredients for baking. In our second, we introduce a pair of child's hands with the grandmother's framing a cake recipe, and in the third, Edith being helped into her apron. Each follows logically, though the second and third might be shifted in position without doing any harm to the sequence of our story.

Avoid the appearance of "acting." Have your people walk into the scene and stop them at the point where you want to catch the picture. One word—"Halt!"—is sufficient. By this means facial expressions usually will be relaxed, and the action appear as though it were stopped by the camera and not by the subject.

I think, too, that rather than attempt to carry the focus sharply throughout, it is a good plan to direct the camera's attention always toward the main character. We're interested, first, in people; second, in things. Don't be afraid of letting both foreground and background fade a bit if your character is placed near the center of the field. If two people appear, focus on the more important.

Some of you may not approve of this method of focusing. To you I say, remember that we are making a movie, with stills representing our sequences. Were you to blow up a similar frame of movie film, similarly focused, you would get the same relative sharpness and fuzziness. Keeping your main point of interest sharp likewise draws attention to that point, easing the eyes' task as they scan the print in search of the center of interest.

Remember, as you shoot, it is not enough merely to get likenesses of your subjects. A good picture combines silhouette and a strong black-and-white pattern relieved by adequate tonal range and form. The play of lights and shadows enables you to estimate dimensions. As for a human subject alone, the outline or shape of the head is as important in revealing character as any other factor. Lighting is the key to such development.

Remember, too, lighting is simple unless you make it complicated by trying for unusual effects. Doesn't nature give us one strong, main light—the sun? Well, let's follow nature by relying on one main light, filling in with two or three secondary lights to keep the shadows from going too dark. Just remember the formula, "main, fill, and background," and you won't go far wrong. Should you run into difficulties, turn out the lamps and start again, placing the main light and filling in from there.

Try to remember as you shoot that cinematographers on the Hollywood movie lots get no second chance to improve their pictures by enlarging and cropping. Neither will you, if you expect to display contact prints. Fill the entire frame with the scene as you want to see it on the negative. When you press the button, the picture is made. That's the movie way, and that's what we want: a movie sequence in stills.

To make the illusion complete, it is well to keep the prints to the proportions of a movie frame, which is 3" by 4". If your camera takes a square negative, mask the negative in the camera to get those proportions, or place a bit of tape over the finder so that you see the area you expect to fill. One more tip: if your camera has no ground glass, leave a small margin around the edges as viewed through the finder so you can crop a trifle and not lose any essentials of the scene.

With limitless subject matter right at your elbow, you should have little difficulty in picking an idea. No Hollywood cameraman knows better how to develop a theme than can you, working with material you know intimately. How about dad at his workbench repairing junior's tricycle? Establish the scene with a shot of father at work, junior running into a tree, the boy limping through the door with the velocipede, dad and junior examining the wreckage. You can go on from there, just as we show Edith helping to bake her first cake. Or mother sewing sister's torn dress, the doctor curing Willie's mumps, brother playing an April Fool's joke on sister, the children threatening trick-or-treat on Halloween—these are all ideas.

Movement, which means action or conflict and a solution or climax—that's the eternal pattern of fiction and motion pictures. In a series of ten pictures, you can get the movie feeling. I venture to predict the family will show greater interest in your photographic hobby once you get some of them into a "still movie," especially if you mount the pictures on stiff cardboard so the whole story is seen at a glance.

Mixing over, the batter is poured, Edith's into her one small tin, grandmother's into full-size cake pans

Here the camera moves up for a close-up of the stove, logically showing the clock and controls

Out of the oven, the cake is examined. It is routine with grandmother, but note Edith's pleased expression

Iced and ready for sampling. What youngster can resist a taste of icing before it hardens?

And last, a smacking climax. Yum! Yum! Ed th consumes a big slice of the first cake she has helped to bake. There's no question of how well she is pleased with the venture. You'll be as well pleased with "still movies" made of your family

Trick Set-Ups

AMATEURS who wish to compose striking pictorial illustrations can learn a lot from the methods used by professionals The main requirement is imagination and originality

What would you do if you were given a dozen small pieces of structural steel for making a picture to illustrate an article or advertisement? That very problem was solved by the Kauffman & Fabry Company, Chicago photographers, in the remarkably ingenious way shown in the accompanying illustrations

First, using ladders as a support, they set up a framework which looked like part of a steel building in the course of construction. From the top of this they hung a small borrowed chain hoist. Eight short pieces of the structural steel were then swung in place, and the camera, with a 7" lens, was set up about 3' from the front end of the bundle

A photo mural showing skyscrapers was placed behind the set-up, and a cut out photograph of a riveter was stuck on one of the steel beams to add a touch of human interest The shot was made on panchromatic film with a 30-second exposure at f 32

Of course, this represents a large-scale example, but its principles apply on a small scale to amateur work of the same type

FOR CAMERA USERS

CONTACT PRINTING of negatives from 35 mm. to 4" by 5½" is possible with a new unit that permits strip printing of many roll films as well as printing of single frames. The box is equipped with four adjustable margin masks, a side slot to receive diffusing materials such as ground or opal glass, and a pair of white-etched scales illuminated from below by the ruby light.

TITLES IN A WIDE RANGE, including turnover, revolving, scroll, superimposed, and combinations, can be made with the accessory below. In the kit are two rollers with handles, a scroll with printed titles, a blank scroll, quotations, an 8" auxiliary lens, a set of 25 titles and backgrounds, a translucent screen for rear projection, and clear celluloid for superimposed titles.

MEASURING PREVAILING ILLUMINATION instead of reflected light, this three-dimensional exposure meter contains a hemispherical light collector that transmits light to a photoelectric cell, which generates an electric current that moves an indicator needle. The meter is held near the subject, the collector pointing toward the camera. The hemisphere picks up all effective illumination including back light, and readings may be transferred directly from the dial scale to a computer. Changes in sensitivity are accomplished by a push button and a neutral slide. Smudges on the collector are cleaned off with a rubber eraser.

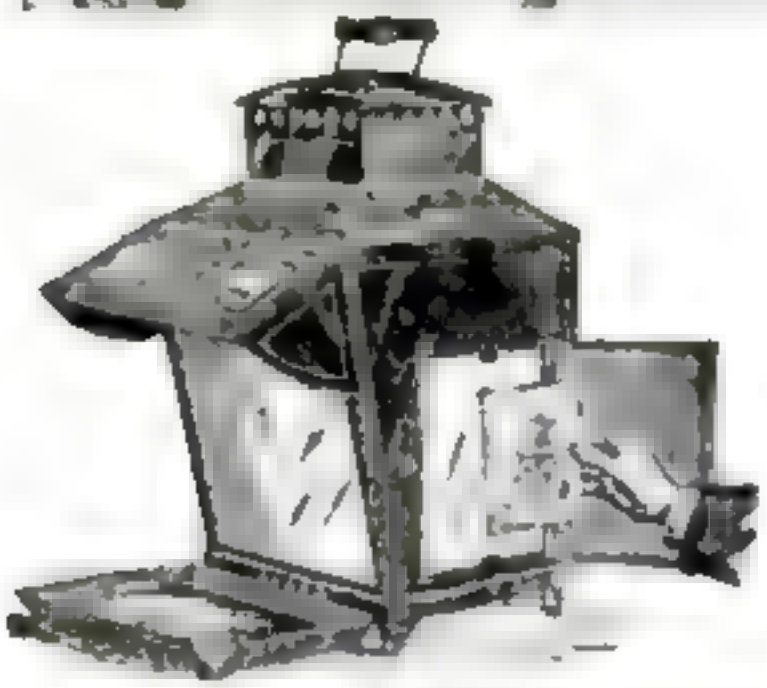
LENS AND FLANGE WRENCHES, one a long tool with flat ends looking roughly like a machinist's clamp, and the other round-nosed, are available in sets. The first is for use on a slotted flange or lens retaining ring, is long enough to reach into the back of a folding camera to open the ring holding the bellows to the front standard, and will open most lens mounts having slotted rings. The other is for flanges having holes instead of slots. Both are fitted with thumbscrews to keep the legs in adjustment.

70TH ANNIVERSARY Feature

Let's OLD-TIME

From "Adventures of America, 1857-1900" Harper & Brothers

"Hold that pose—steady now!" A traveling photographer of the horse-and-buggy days tries a candid shot with his studio camera. Edwin Austin Abbey made the drawing



Darkroom lantern with a "coal oil" (kerosene) lamp. The front glass was ruby colored

Simplicity is the word for this view camera. It's what they used in 1888

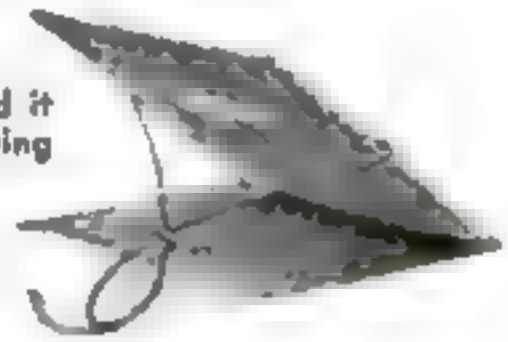
This happy amateur of the early 70's has a *de luxe* portable wet-plate outfit

Take a Look at PHOTO EQUIPMENT

Early type of motion-picture camera in the Los Angeles Museum. It was made in 1895

With this gadget it was easy to lift a slippery plate from a tray

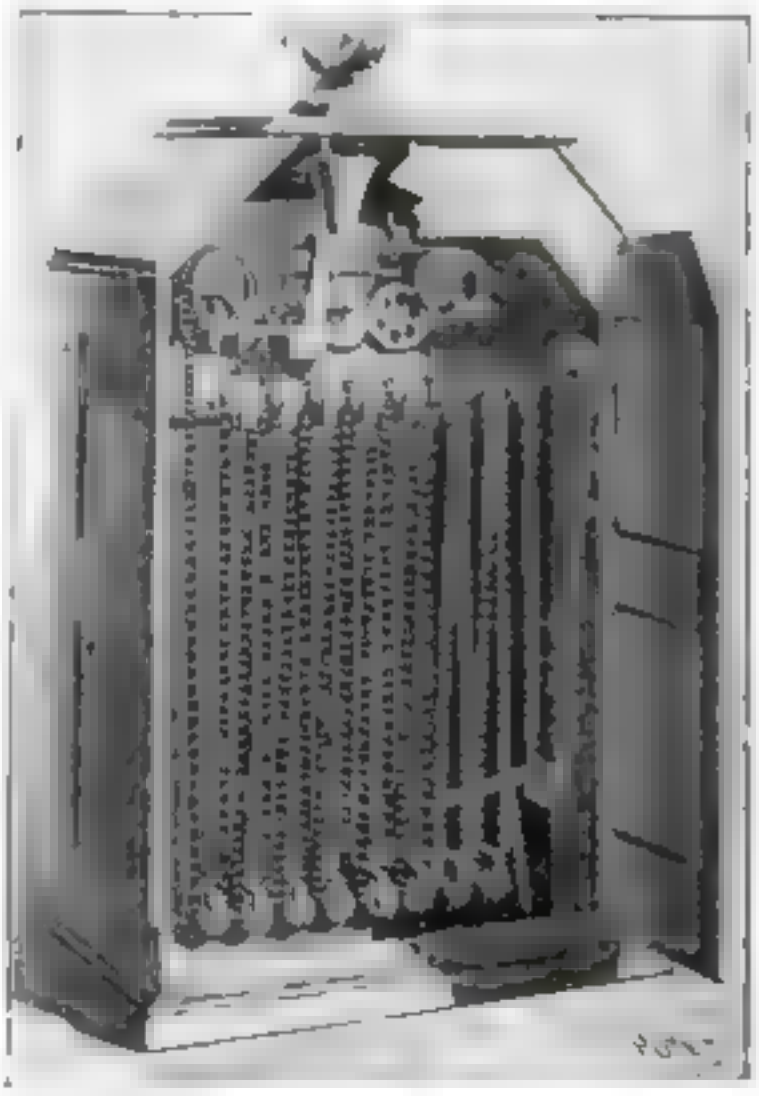
. . . and just as easy to stand it up safely for draining and drying



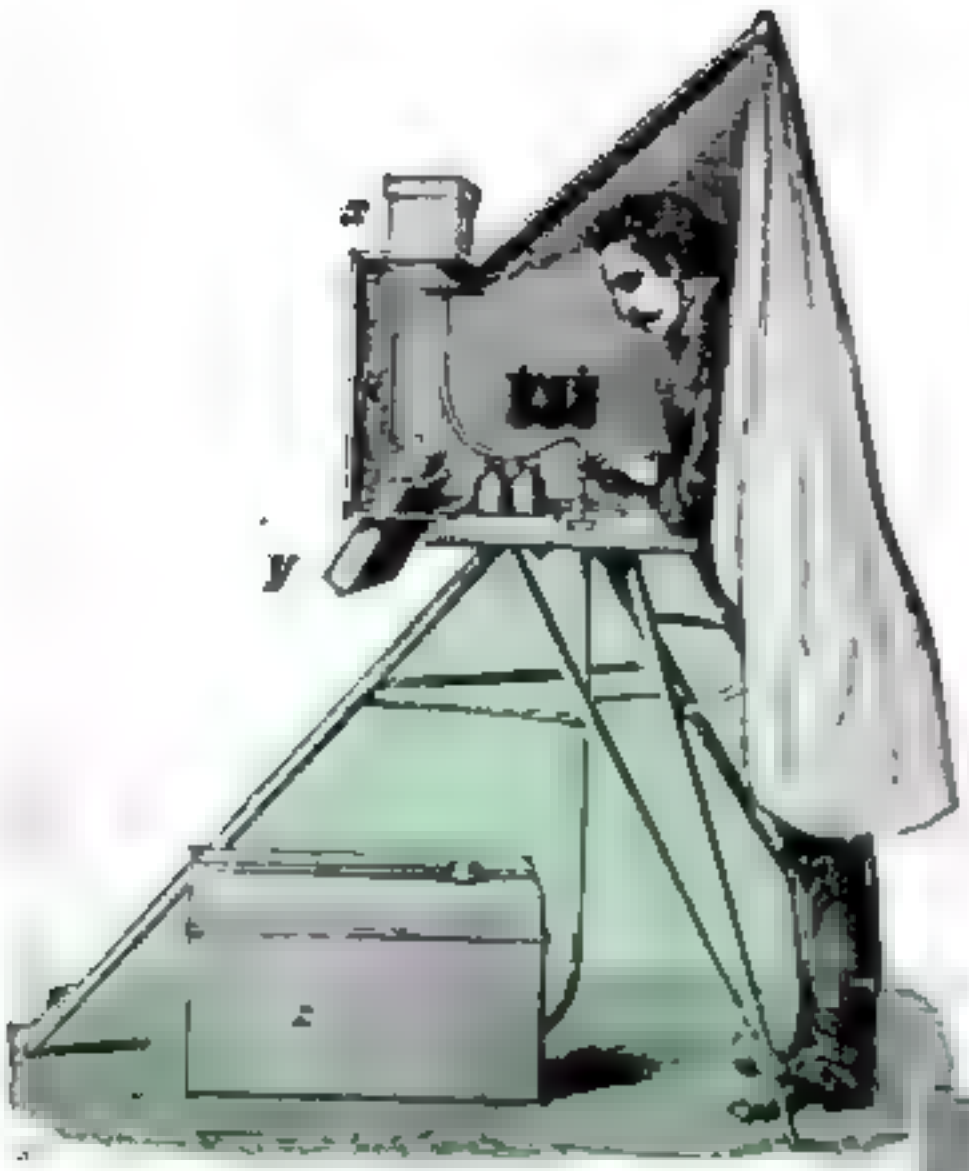
Only 15 cents—a plate lifter that was worn like a thimble

OVER

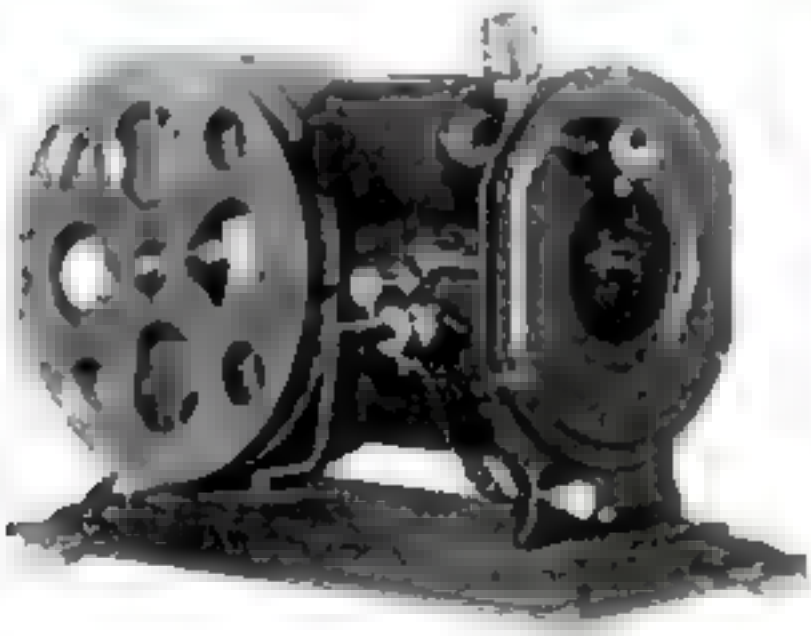
The bicyclist of 1886 could get this camera, designed to ride the handlebars of his lofty rattle-bone contraption



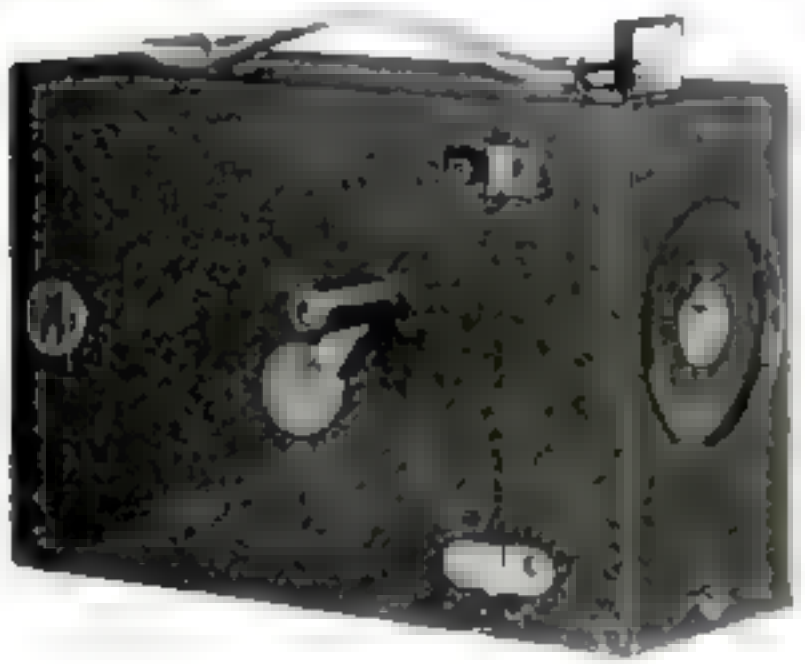
Edison's kinetoscope (invented 1889) was a peep show with a moving film of still photos



A portable dark tent for preparing and developing early collodion negatives—wet plates—in the field

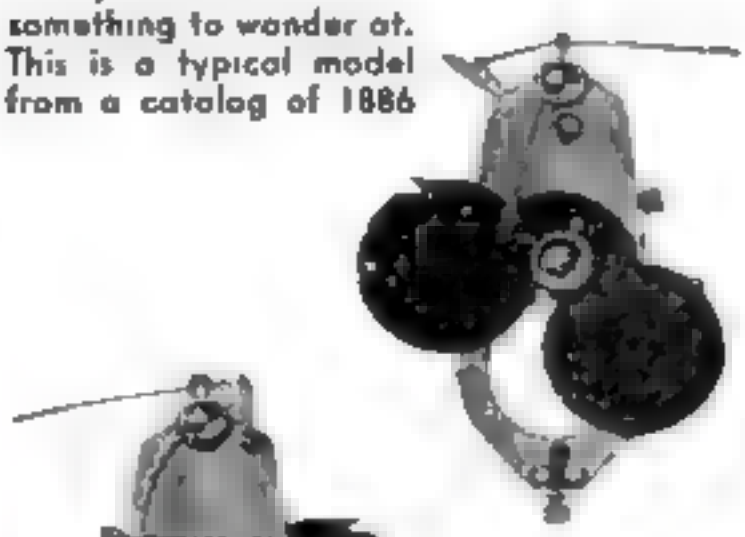


Amateur movies started well with this hand-operated 16-mm. projector, designed in 1922



. . . and this hand-operated 16-mm. camera is of the same vintage. Both were marketed in 1923

Early shutters were something to wonder at. This is a typical model from a catalog of 1886



The upper view is the front of the shutter; the other one, the rear

After the roll-film camera, patented 1881, came the box camera. Here's an early one (1890). . . . And who couldn't pose prettily before such a background!

Wartime Photo Restrictions

NEW FEDERAL LAW TO DEFINE EXACTLY WHAT PICTURES YOU MUST NOT TAKE

SO MANY scare stories have appeared about wartime restrictions on photography that some of us are almost resigned to storing away our cameras for the duration. Actually, the situation is by no means such as to make the amateur forsake a stimulating hobby. A proposed Federal law (Senate 1707) will affect him by imposing certain necessary restrictions, but there will still be plenty of interesting material for the lens-and-shutter enthusiast to shoot.

Forbidden by this bill is the photographing of naval stations and yards, military posts, forts, arsenals, airfields, and all other naval and military reservations and premises used for purposes of national defense by the Army, the Navy, or the Coast Guard. It is also taboo to snap vessels, aircraft, weapons, and other equipment located on such premises *or in adjacent waters or designated defensive sea areas.* The bill likewise prohibits the photographing of vessels, aircraft, weapons, and equipment under repair or in process of construction either for our own government or for any of the United Nations, as well as the factories, shipyards, plants, storehouses, or other premises on which such war material is manufactured or kept, and the areas adjacent to such places. As it is impossible to know in most cases whether a factory is a defense plant or not, or whether a warehouse is filled with munitions or with household furnishings, the wise course is to refrain from shooting such doubtful subjects.

Unlike the old Espionage Act previously in force, the proposed new measure will not require the authorities to prove that illegal pictures were taken for the wilful purpose of aiding the enemy. The amateur who takes such pictures is therefore fully liable to its penalties, which are a possible fine of not more than $1,000, or imprisonment for one year, or both.

It is not intended to prohibit the photographing of naval ships and planes, personnel, weapons, and the like when such subjects are not in or adjacent to areas in which photographing is forbidden. There is no restriction on taking pictures of planes in flight or on the ground when away from military or naval reservations, troops on public roads, and so forth. However, in many cases the authorities in charge would prefer that such pictures should not be taken, and photographers should consult the officer in command before attempting any shots. Service men on leave may, of course, be photographed freely

Visitors at commercial airports are not permitted on the fields, and as the Civil Aeronautics Administration forbids the taking of photographs from the air, passengers are required to surrender their cameras, which are locked in baggage compartments. However, there is no restriction against snapping passenger planes in flight.

The foregoing covers only the proposed Federal regulations. Bear in mind that local laws, municipal ordinances, and the like may impose additional restrictions. In some localities, for example, it is illegal to photograph bridges, dams, municipal buildings, water fronts, or power plants. Under the law of trespass, railroads, factories, mines, and public utilities can prohibit picture taking on their premises.

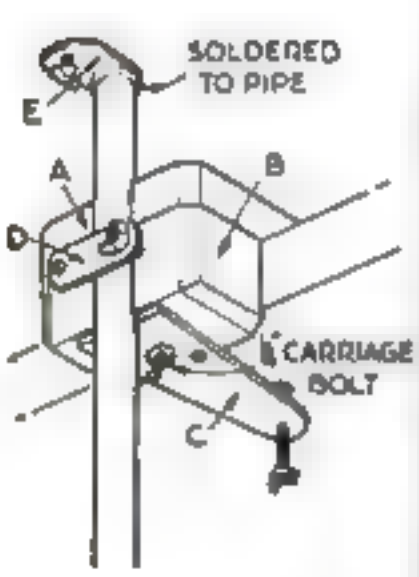
The safe course is to inquire at a police station or city hall before you shoot, and if in any doubt whatever in regard to a subject, to ask specific permission. Even if no legal action is taken, unauthorized snapshooting can result in much difficulty and embarrassment. There are plenty of perfectly safe and fascinating subjects for your camera indoors, in the country, in most public parks, and in your own back yard.

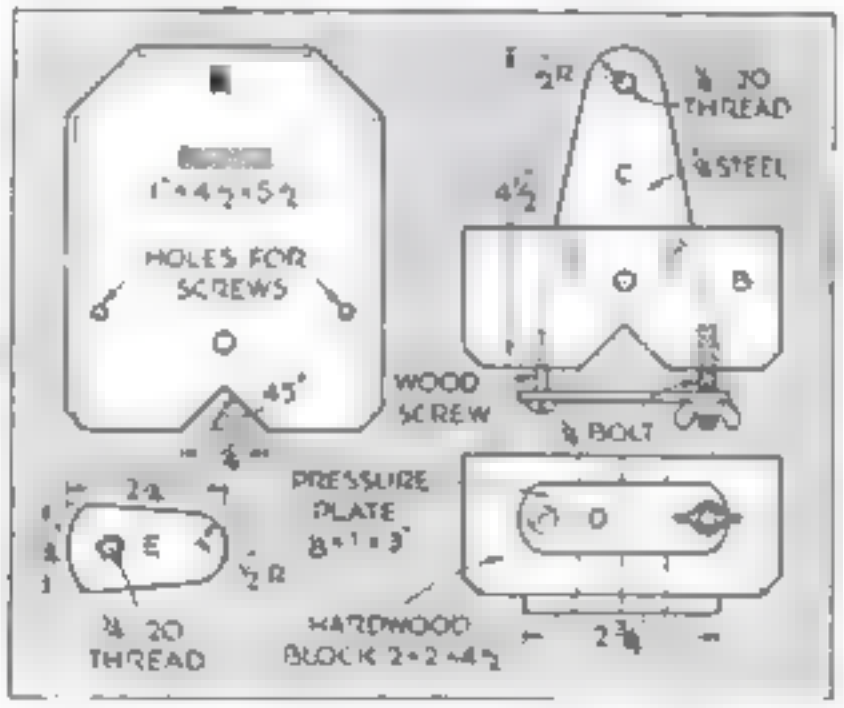
The patriotic photographer will refuse to take *any* picture that might be of value to the enemy should it fall into the wrong hands. He will bear in mind the motto that hangs over an official's desk in Washington: "Cameras Are Guns—Pictures Are Bullets."

Liquid-Rubber Coating Renews Nonslip Tips on Tripod

RUBBER-IMPREGNATED tripod feet that have hardened with age so that they slip on smooth surfaces can be renewed with white liquid rubber or black latex, such as is used for making rubber molds. Clean the tripod feet thoroughly with a brush and grease solvent to remove all dirt and grease, put the liquid rubber into a suitable container, and dip each foot separately, taking care to have the rubber reach well up on all sides. Hang the tripod up after dipping so that the rubber runs down to form thick buttons on the feet. If necessary, dip two or more times, allowing three hours between coats. Let the last application dry overnight before using the tripod.—G. R. S.

Adjustable Camera Support Is Clamped to Edge of Table

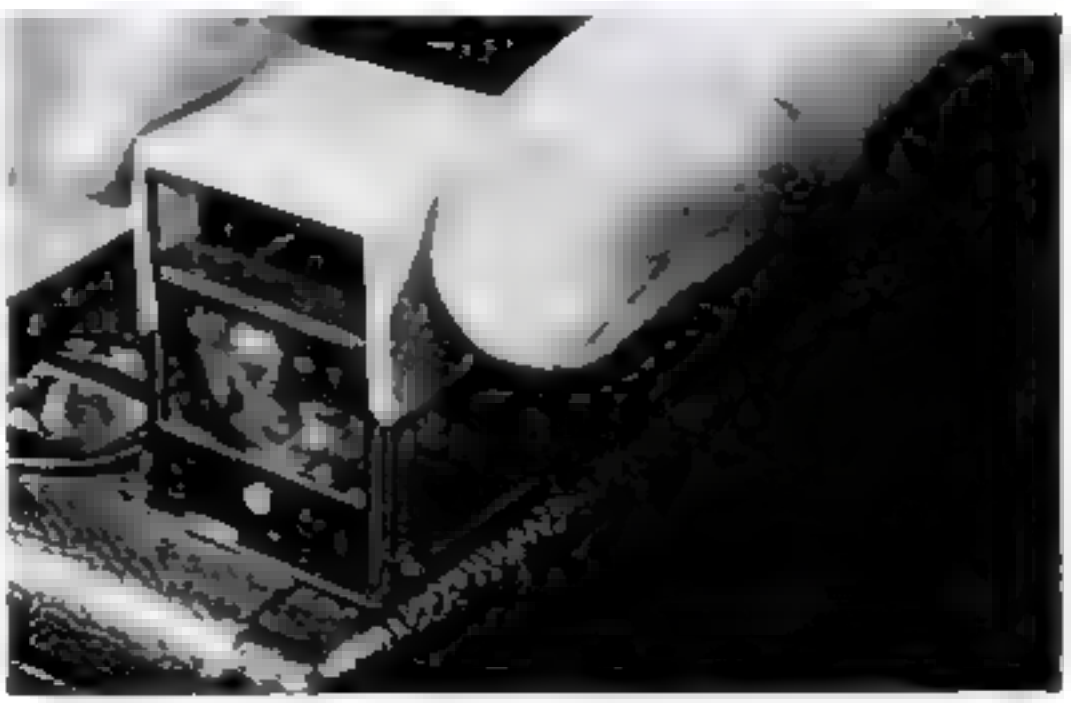




THIS camera stand and clamp provides a firm support from which to shoot table-top or still-life pictures, and can also be used to hold lighting equipment. It consists of a brass pipe that can be slid up or down in a V-notch and held in place with a pressure plate and wing nut. The top of the pipe carries a camera screw, and any home-made or commercial tilting top may be used.

Simple View-Finder Shield Eliminates Glaring Reflections

VIEW finders that consist of a negative lens and a peep sight are sometimes hard to use in bright sunlight because of glare from the concave lens surface. This can be eliminated by slipping over the lens frame a shield made of metal from a tin can and shaped as shown. Paint the inside a dull black and finish the outside in some lighter color so the shield will be easier to find if dropped. This expedient can, of course, be used on either a still or a motion-picture camera, although shown on the latter.



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AT YOUR FAVORITE NEWSSTAND

Gus Spotlights Lighting Troubles

(Continued from page 144)

generator, the ammeter, and the battery. Remember that a good connection means metal-to-metal contact over the full area of the wire which carries the juice, and that either corrosion or dirt will prevent that sort of contact."

"Right," Dr. Marvin said. "I'll keep an eye peeled for headlight flare-up. But how about too low voltage?"

"If your headlights seem to be growing dim," Gus said, "trust your eyes and do some checking for low voltage. It's worth finding and correcting. A 10-percent loss in voltage means a 30-percent loss in candlepower.

"The cause of low voltage isn't as easy to locate as the cause of too high voltage because low voltage has more possible causes. I always start by checking the battery—very low water in the battery can cause battery-voltage drop under the load of the headlight bulbs. Then I check for badly corroded battery cables, and then for poor ground connections. Next I close the lighting switches, and check across them for voltage drop. If I find any drop, I examine the wiring carefully, and give special attention to connections. If I find a connection made by just twisting the strands of a wire around a screw and then fastening them I'm pretty certain that I've found the cause of the trouble. When a wire is terminated that sloppy way, corrosion will get in its dirty work before very long and cause voltage drop. Such sloppy connections should be replaced by a soldering lug—or at the very least the end of the wire should be dipped in solder before it is twisted around the screw."

"If I'd been driving my new car with the sealed-beam headlights, I wouldn't have had this trouble tonight," Dr. Marvin said.

"Maybe not," Gus agreed, "and then maybe so. It was just one of those things . . ."

Suddenly all the lights in the shop went out.

"What's this?" Dr. Marvin demanded. "A blackout?"

"Looks like it," Gus said. "The second one tonight for us."

The lights flashed on again. Joe Clark was standing in the office door, grinning at them. "It's after twelve o'clock," he announced. "Don't you two fellows ever want to get any sleep? When you two get to talking about automobiles, one of you is as bad as the other!"

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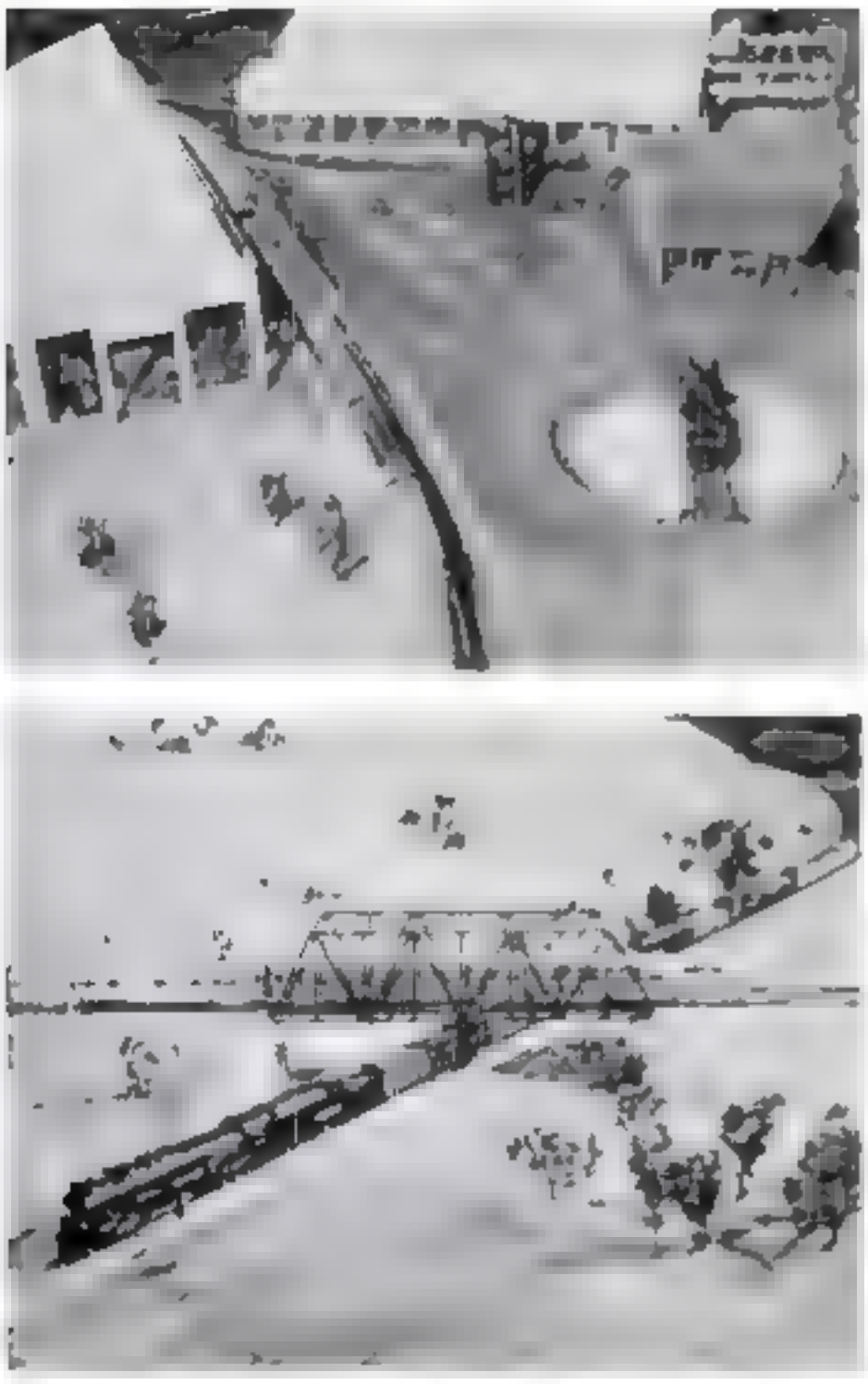

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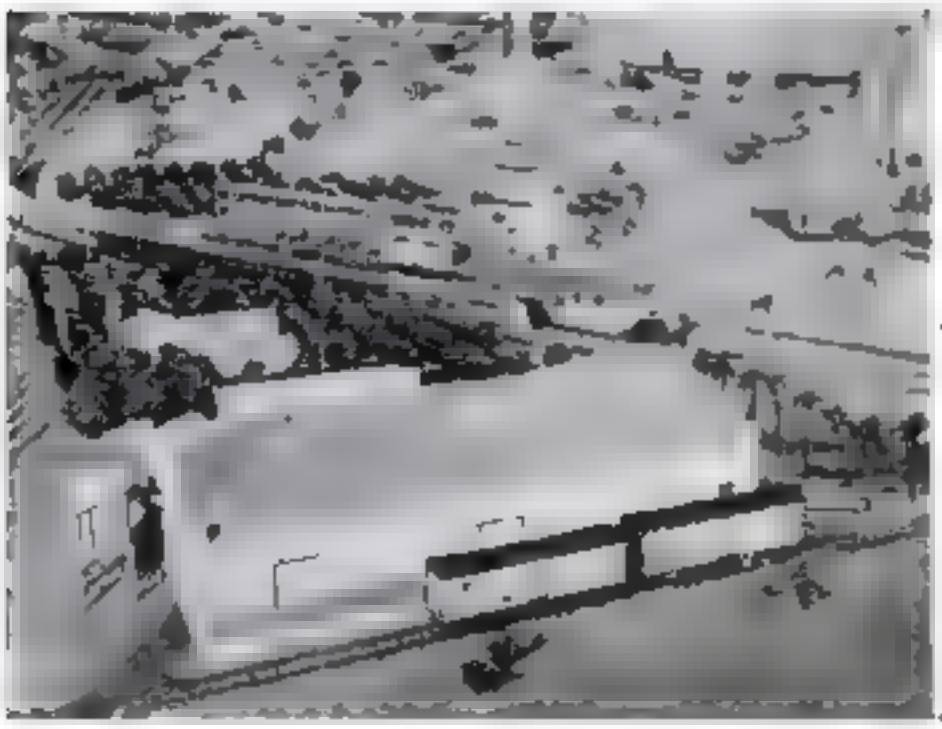

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No Shortage of Problems

(Continued from page 51)

made. That was on December 17, when the Wright Brothers set the world's first non-stop record of 120 feet in 12 seconds.

You would think a feat like that would have made headlines in every newspaper in the country. But, as a matter of fact, when the brothers telegraphed to their sister Catherine in Dayton an account of the flight, she couldn't find a single reporter willing to use the story. She rang up one of the local papers on the telephone, and the boys were playing poker and the phone rang and rang until finally one fellow answered it and said, "Well?"

"This is Catherine Wright," she replied, "and I have just received a telegram from my brothers. It says: 'We have just made the first flight in a heavier-than-air machine and will be home for Christmas.' "

After she had finished, the fellow said, "Well, I'm glad to hear the boys are going to get home for Christmas."

That is a true story told to me by the reporter himself.

"I would have been crazy if I had said anything else," he explained. "In the first place, we had all been taught it was impossible to fly a heavier-than-air machine. Anyone who thought he could fly was crazy.

Whether or not a thing like that is crazy depends on which way we have our sights leveled, forward or backward. People of limited vision have decried the practicability of every invention in the history of man. Still the human race has progressed

If we are to have any hope of continuing that progress, we must maintain our laboratories intact and encourage our inventors. The emergency of war is going to provide a great impetus for scientific research. In many ways, this is an era of unrivaled opportunity for the individual inventor.

We need never fear our running out of problems or opportunities. The progress of the human family is like the old story of the man who went out to slay the dragon with a hundred heads. He was given a charmed sword and was told, "This sword will cut off any head that the dragon has. There is just one catch to it. Every time you chop off one head, two more will grow in its place."

Every time we solve one problem, two more grow in its place. That is the reason why I say we need never fear our running out of opportunities in the future.

Our problems today are our opportunities tomorrow. There will never be a shortage of problems.

How Flyers Are Redesigned

(Continued from page 123)

skin of the rest of the body to lose heat much more rapidly.

With pressurized suits or pressurized cabins, it would not be necessary to skate on such a thin edge of oxygen. So far, pressure suits are too clumsy to be very useful, and for military uses pressure cabins are dangerous. Small bullet holes can be easily patched, but a broken window or a hole from an explosive shell would be disastrous—at 51,000 feet, for instance. Pressure cabins are commercially useful for comfort at much lower altitudes, and the Air Corps has experimented with them successfully. But in combat at high altitudes the men inside will still have to use masks and have emergency oxygen flasks for parachute jumping.

It was only in 1939 that the oxygen mask came into use in our Air Corps. Before that the flyer took oxygen from a pipe stem held between his teeth, and it fed him a constant flow from a compression tank. The mask in common use today, developed by Drs. Boothby, Lovelace, and Bulbulian of the Mayo Clinic, is a far cry from that; and even this BLB mask is now obsolete for combat.

The BLB mask fits tightly over the nose and mouth. Oxygen flows at constant rate (fixed manually according to need) into a rubber bag, from which the flyer sucks his breath. When he exhales, the first 150 cc. of the exhalation is pure oxygen which never got to the lungs, and it goes back economically into the rebreather bag. When the bag is full, the rest of the exhalation goes out through a sponge-rubber disk, in a turret in front of the mouth. Moisture from the breath collects in the sponge rubber, and in an unheated cabin it is likely to freeze up tight. The mask turret also gets in the way of the bombardier's sight.

One mask has eliminated the turret and it has its breathing apparatus down inside the flyer's clothing, where body heat keeps it from freezing. This mask is equipped with a valve which automatically feeds the right quantity of gas from the tank, as the flyer inhales. Development of such valves has been one of the most difficult designing jobs in the development of oxygen masks. No matter how dry the oxygen was, they were likely to freeze up. This was especially true formerly when oxygen was carried in tanks at a pressure of 1,800 pounds to the square inch. In addition to the cold of altitude, the expansion of this gas through the valve had an effect of refrigeration, and lowered

(Continued on page 224)

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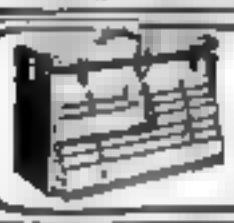

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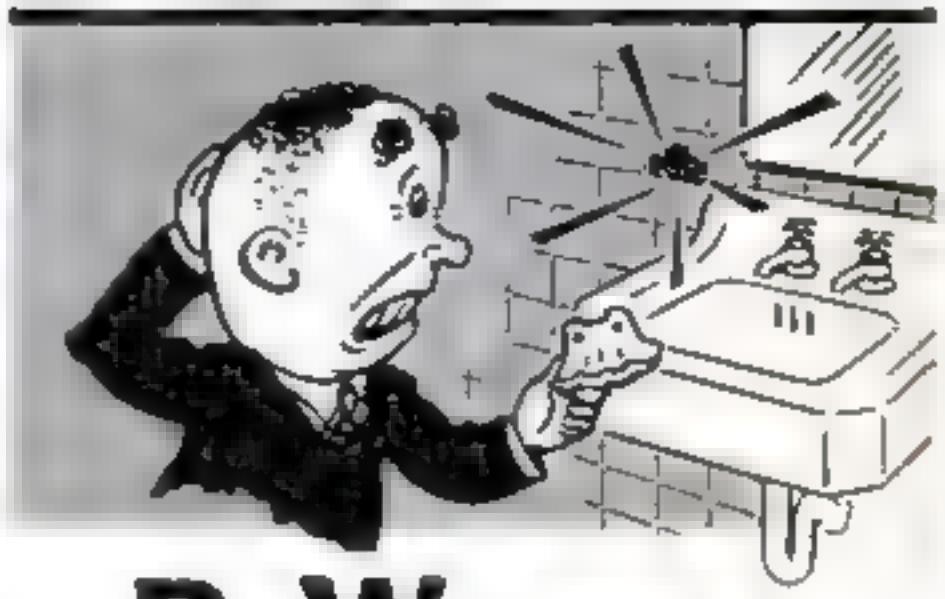

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How Flyers Are Redesigned

(Continued from page 222)

the temperature by several degrees more.

Only a certain number of men in the Air Forces are able to work at the highest altitude. Others are afflicted above 30,000 feet by aeroembolism, known to sandhogs and divers as the "bends." At extremely low pressure, atmospheric nitrogen dissolved in the blood is discharged as bubbles, like the gas in an opened soda-water bottle. This causes itching, rash on the skin, and sometimes excruciating pains. By breathing pure oxygen and exercising before leaving the ground, it has been found possible to wash most of the nitrogen out of the blood. But with some men this doesn't work.

One of the hardest jobs of the flight surgeons is to persuade flyers to accept their findings, especially as to the need of oxygen between 10,000 and 15,000 feet. The first effect of anoxia, oxygen lack, is a feeling of exhilaration and well-being—much like the notion of a man, after a half dozen cocktails, that another little drink wouldn't do him any harm.

In a Navy low-pressure chamber, at 35,000 feet, a flyer once impatiently removed his mask. Horrified doctors hurried to increase the pressure, meanwhile held a stopwatch on him. He collapsed in 35 seconds. Another Navy flyer learned his lesson in a strange way. Flying above 20,000 feet one day without oxygen, he noticed that his instrument board lacked a bank indicator. Diving to lower altitude, he looked at his instrument board and found the bank indicator back in its proper place.

Pilots flying all day at 15,000 feet with oxygen are warmer and suffer less fatigue than if they fly at 8,000 feet without oxygen. All pilots are supposed to use oxygen above 10,000 feet, but the pilot of a single-seater is pretty much his own master when he gets in the air. He needs to be convinced.

The flight surgeons are now installing more than forty altitude chambers in various parts of the country for indoctrination of members of combat crews. A machine gunner is put in the chamber with one of those nickel-in-the-slot machines which shoot light beams at moving airplane targets. He starts out making a fine score, and as pressure is decreased he fires away with increasing confidence, but with rapidly deteriorating marksmanship until he can't hit the target at all. Then he is given oxygen and immediately the shooting improves. The pilot, watching the procedure, learns his lesson as well as the gunner.—HICKMAN POWELL.

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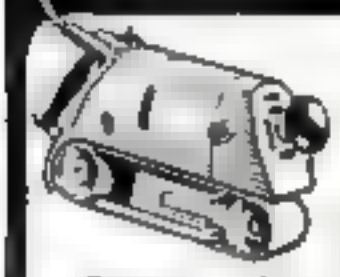

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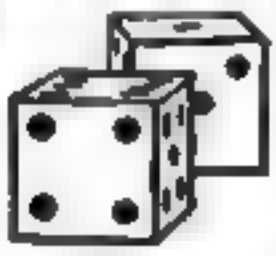

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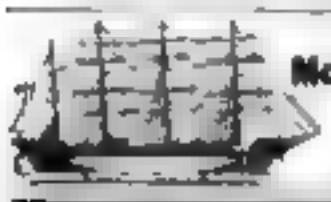

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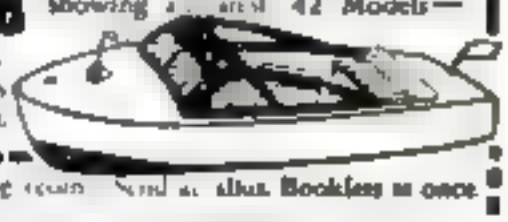

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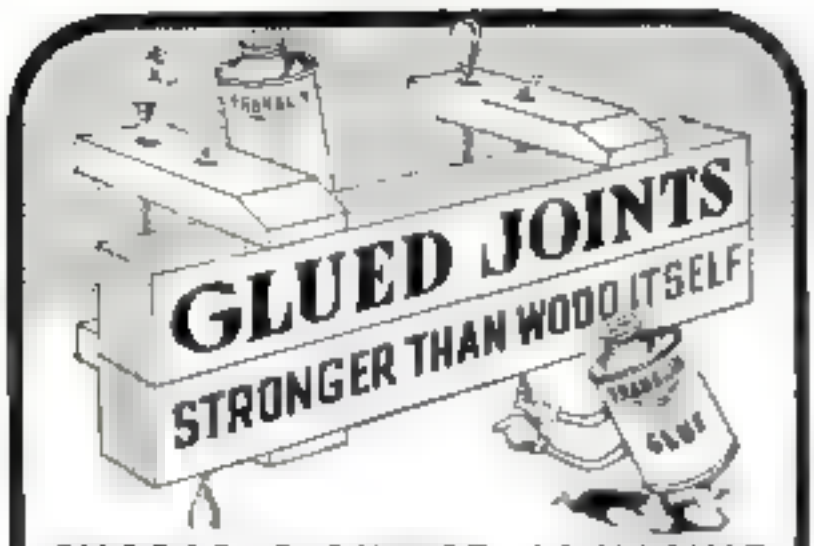

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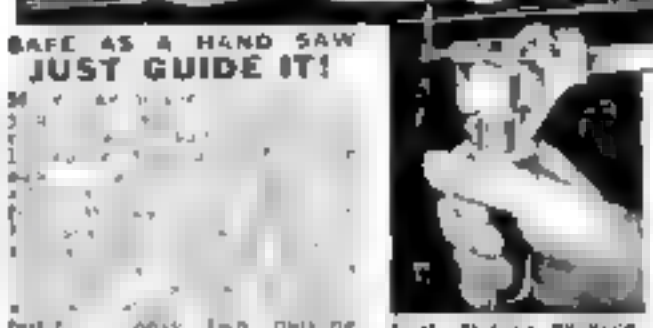

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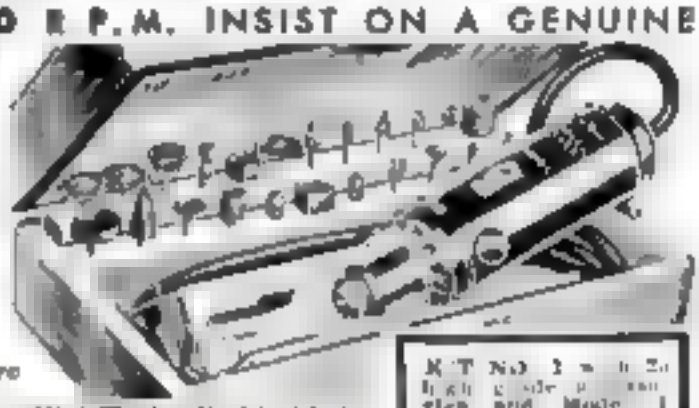

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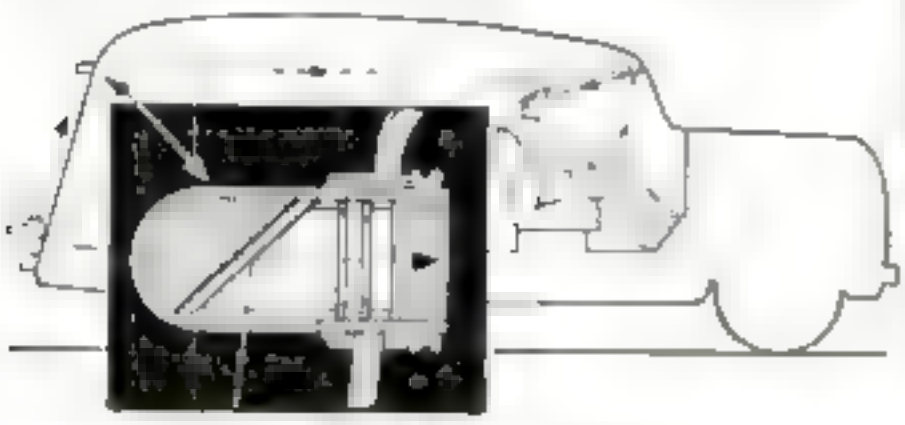
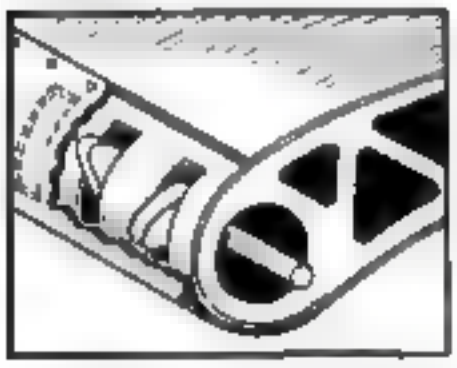
FISHING RODS AND BAITS • GOLF SHAFTS

With the Inventors

TO SHOW whether a car's tail light is working properly, a new "periscope detector" is mounted in the body above the rear window. When rays from the rear lamp are directed upon the license plate above it, they also enter the periscope,

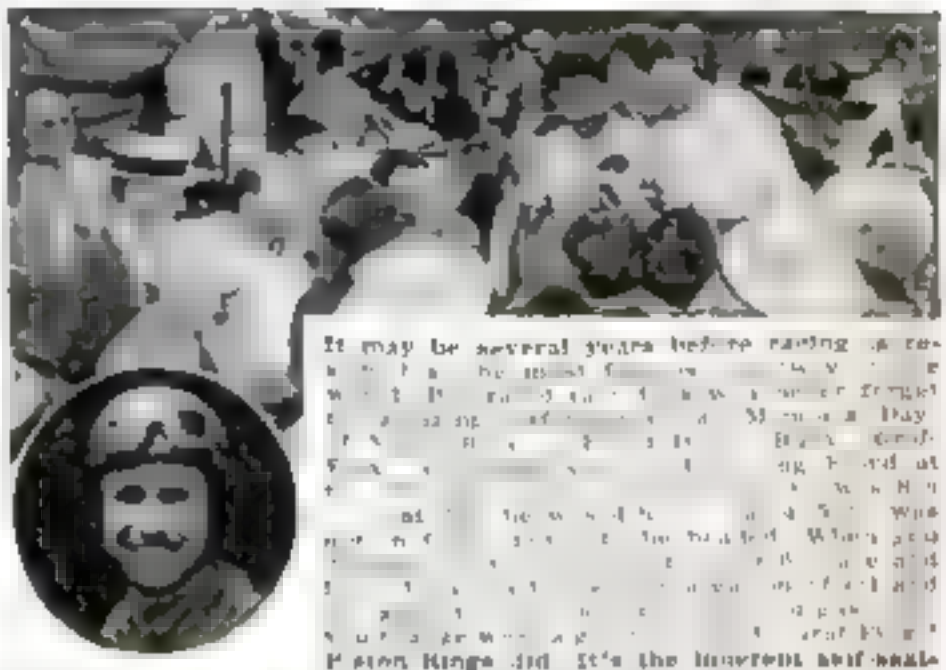


where an oblique mirror directs them forward to the conventional rear-view mirror and thence to the eyes of the driver. Thus, without leaving his seat, he can tell that the lamp is in operation. So that the reflection will not be confused with other lights encountered along the road, it may be given distinctive color and form, such as a green star, by a masked and tinted window in the periscope. According to the Irish inventor, who has just obtained a patent in this country, the scheme should avert accidents due to a burned-out bulb or broken connection in the tail lamp, which prevent it from being seen by an overtaking vehicle. . . . ICE THAT FORMS ON AIRPLANE WINGS, destroying their lift and endangering the pilot, is disposed of in a new way by Leopold C. and Walter J. Schmidt of Jersey City, N. J. Along the leading edge of each wing, a strip of flexible material covers a row of slots. When an inner shaft is turned, cams protrude through the slots, flexing the covering and dislodging the deposit of ice. An important aid is a flexible fin, protruding from the covering, which flutters in an air stream and has been found to prevent formation of a continuous sheet of ice across it. The cam-bearing shaft, which preferably is constructed of lightweight tubing, may be



(Continued on page 230)

WHAT? NO RACE AT INDIANAPOLIS?



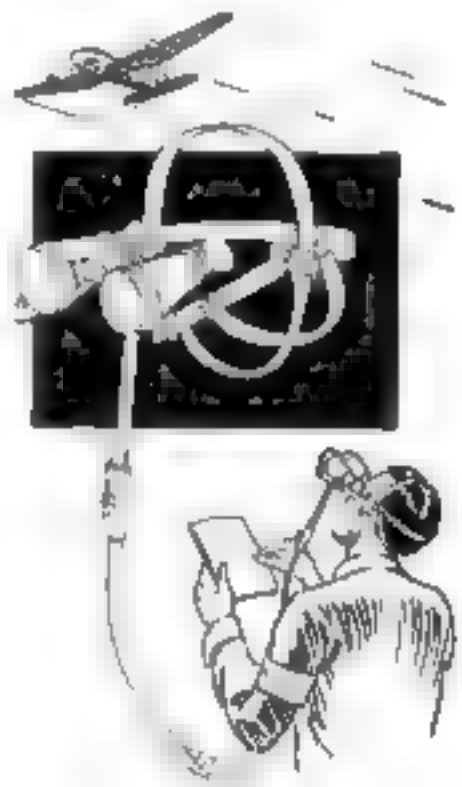
Top: Wood Ross and Floyd Davis accept word in famous "Victory Lane" at Indianapolis. Below: Ross and his best victory smile. He's a booster for Bard

It may be several years before racing is re- [illegible] Piston Rings did. It's the improved self-seating and self lubrication qualities of the "Graf-Flok" process that reduce friction to a fraction [illegible] eliminate the "run-in" period . . . that are making Bard rings famous on the highway and speedway. Mail the coupon for free folder and your copy of the Handy Handbook.

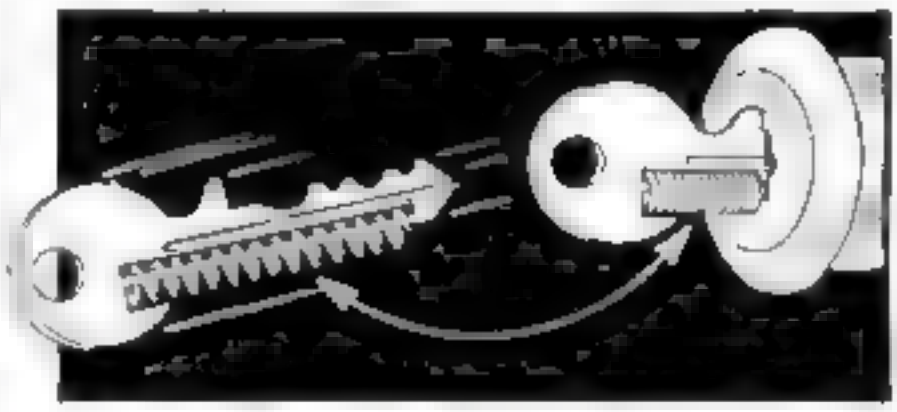
With the Inventors

(Continued from page 229)

turned either by motor power or by hand. . . . BY PROVIDING A FIRM SUPPORT for heavy field glasses, Leonard C. Corcoran, of University Heights, Ohio, steadies the field of view, and also leaves the user's hands free for taking notes of his observations. The device employs looped headgear, and a vertical bracket of adjustable length, to suit the comfort of the wearer. Clamped to the front of the frame, the binoculars may be aimed upward or downward by rotating them on pivots. The accompanying illustration suggests one possible use of the invention,



by a civilian air-raid warden, for identifying the markings and type of an unfamiliar plane. . . . AN IGNITION KEY that insists on being taken along, when a driver leaves his car, is the creation of Walter Spiro of New York City. If an absent-minded owner fails to remove it, the key thrusts itself into his hand; or, if ignored, it attracts his attention by clattering to the floor. The trick lies in a spring, sliding within a slot in the key. When the latter is inserted, the spring is compressed. Nothing happens, so long as the key is turned; but when the ignition is shut off, the spring forces it out of the socket. Other uses for the self-ejecting key are foreseen by the inventor in locking doors of houses, apartments, hotel rooms, offices, and shops. Because of the simplicity of the device, it offers no obstruction to normal use, but serves as a constant reminder against inviting thievery by leaving a key in a lock. . . . TO KEEP WINDSHIELDS free of dust, snow,

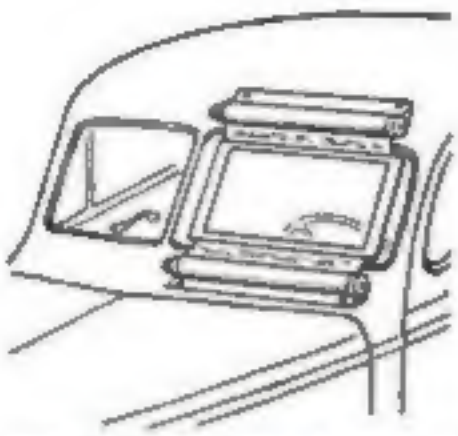


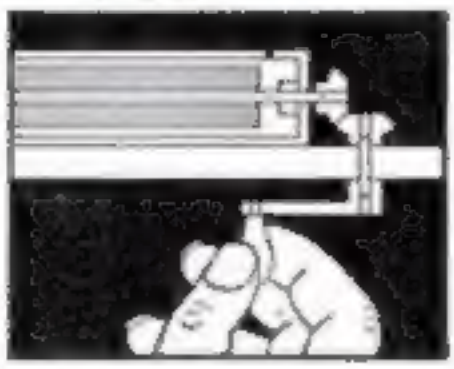
(Continued on page 231)

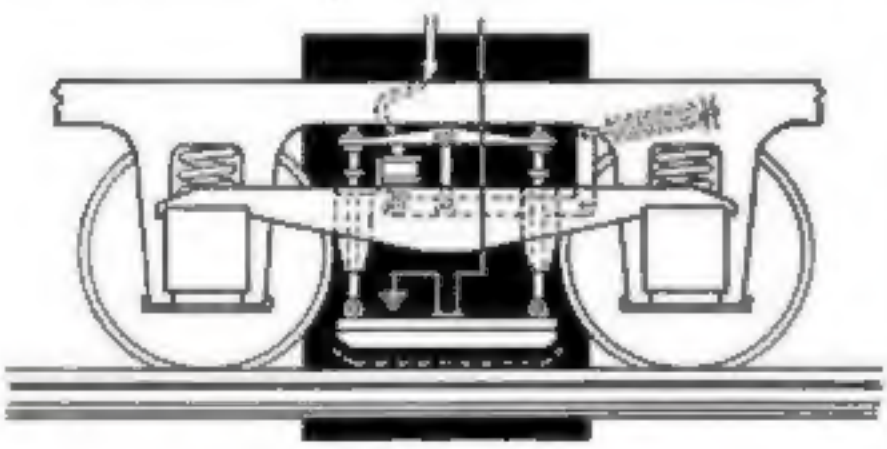
With the Inventors

(Continued from page 230)

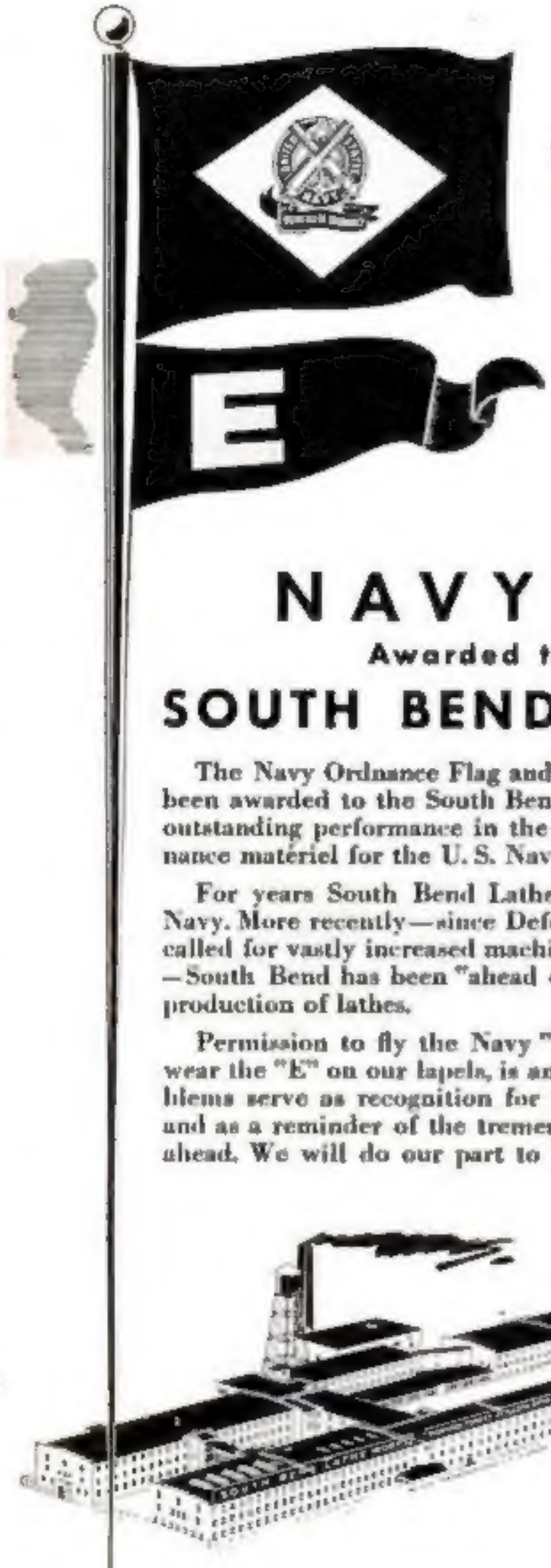
sleet, and insects, a handy aid for motorists has been devised by Milton O. Schur of Berlin, N. H. On the front of the shield, a fitting holds part of a roll of transparent, water-repellent film in firm contact with the glass. When this section of film eventually becomes soiled, a crank within the car winds it up on the lower roller, and brings into place a clean section from the top one. When the entire roll is used up, it may either be laundered and rewound, or thrown away and replaced with a new insert. If the material is tinted blue or amber, it is said to serve as an effective sun shield and to abate headlight glare. The frame may be made of glass or transparent plastic. . . . HIGH-SPEED STREAMLINE TRAINS, light in weight compared with other rolling stock, tend to skid along the rails when brakes are applied for a quick stop. To obviate the difficulty, electromagnets mounted a fraction of an inch above the rails have been used to increase traction. However, they have been







subject to damage by guard rails in crossing switches and frogs, particularly on curves. An improved type that solves this problem has been assigned to the Westinghouse Air Brake Company by its inventor. Electromagnetic bars normally are retracted well above the rails. When the brake lever is operated, however, it applies air pressure to a pneumatic plunger that depresses the bars to the position shown by dotted lines. When the brakes are released, the electromagnetic bar returns to its retracted position.



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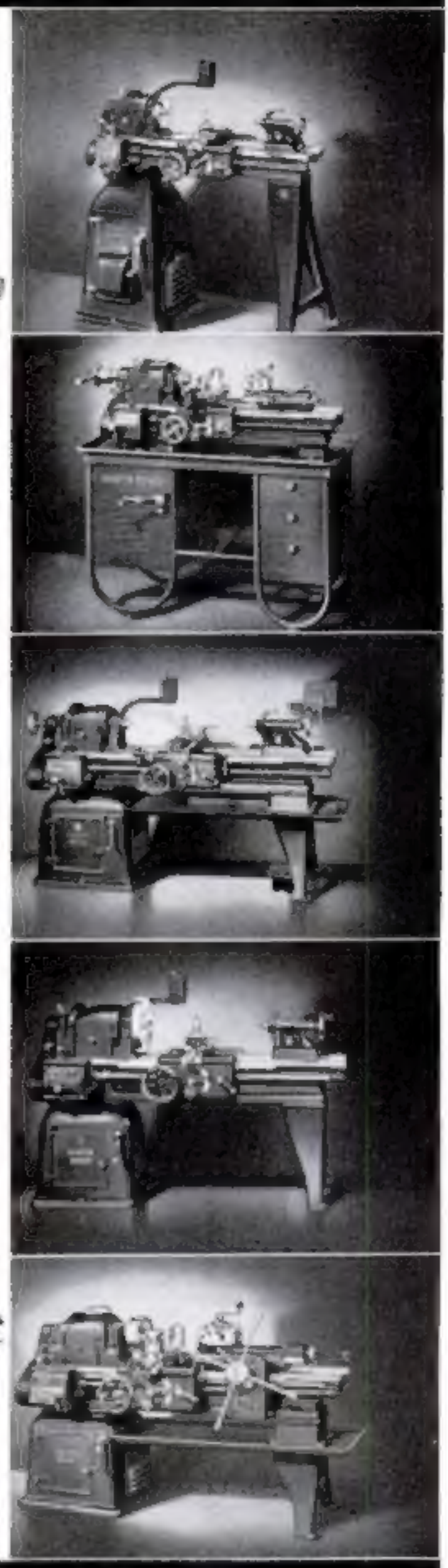

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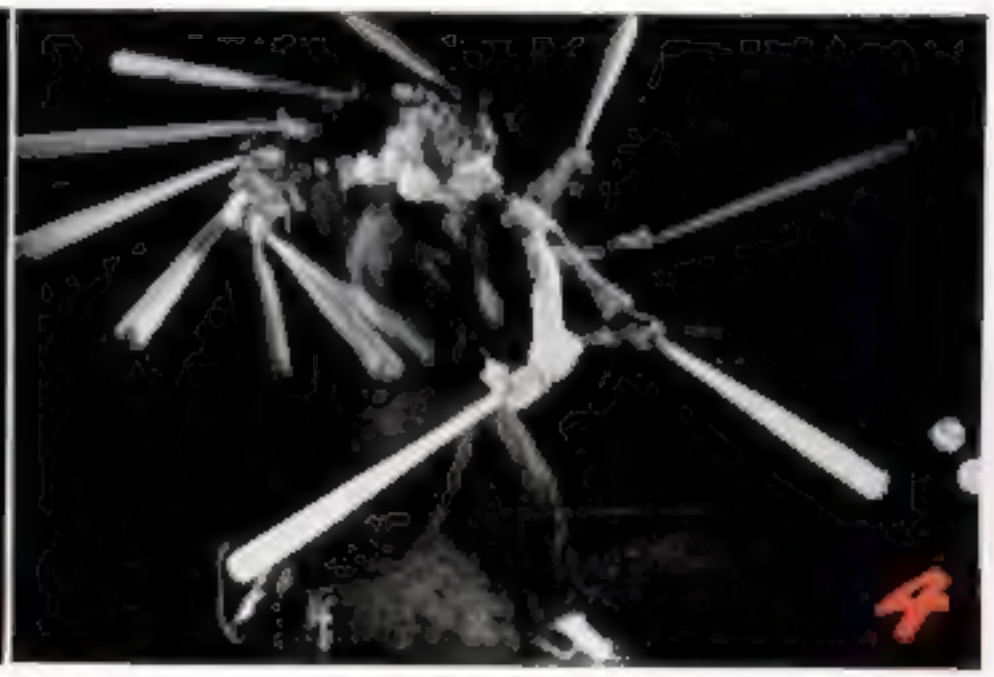

A remarkable series of repetitive flashes taken at 1/30,000 of a second show you the famous Di Maggio swing and follow-through all in this one picture above. Below, at the left, you see Joe enjoying a Camel. Yes, *Camel*—the milder cigarette with less nicotine in the smoke.

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